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The study was conducted to determine the difference in the ability of 2 groups of music students to improve their sensitivity to errors of intonation and to recognize intonation errors in triads and chords within the performing ensemble. The selected sample consisted of students enrolled in conducting classes at Arizona State University, 20 of whom were in the experimental group and 18 in the control group. The control group was exposed only to the traditional method of teaching intonation, and the experimental group listened to 17 prerecorded magnetic tapes that aurally compared intonation errors with in-tune prototypes. The study was limited to the development of intonation sensitivity to the major third, the minor third, the fifth, the minor seventh, and to the pitch of these intervals as they form the major triad, the minor triad, and the chord of the dominant seventh. Students in the experimental group were required to recognize and identify the voice in which the error took place, and to designate the direction of the error. No significant differences were found between the 2 groups in their ability to recognize errors of intonation, and to identify the direction of errors that were flat and errors that were sharp. A list of 12 recommendations for further research is included, as well as a sample of the student handbook that was used in the study. (WM)

FINAL REPORT
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EXPERIMENTAL TAPE-RECORDINGS FOR TEACHING SENSITIVITY TO MUSICAL INTONATION

February 1969

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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Ralph Rizzolo

February 1969

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Arizona State University

Tempe, Arizona

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TABLE OF CONTENTS

INTRODUCTION

Intonation is a very vital ingredient in the performance of music. A knowledge of intonation and the ability to hear and to correct errors of intonation is a necessary skill for the conductor. In the case of the teacher-conductor who is the sole guide for music students in the elementary and/or the secondary school it is a skill that should not be lacking. This is a skill which ultimately determines the aesthetic musical experience, or an absence of this experience.

Often the assumption is made that if a student is able to perform well on his instrument intonation will take care of itself. A further assumption is that since he is able to handle his own intonation problems he will be equally equipped to identify and to solve the intonation errors of the ensembles that will ultimately be under his guidance. Results from these assumptions have caused the student in the music education program to rely wholly on his own talents to develop intonation skills. These assumptions have caused a hiatus in the teaching of conductors in the area of intonation.

This study was designed to test the ability of the music student to improve his recognition of intonation errors by use of a prerecorded magnetic tape. The taped examples permitted the student to compare aurally errors of intonation on intervals, triads, and the chord of the dominant seventh with in-tune prototypes.

THE PROBLEM

The purpose of this experiment was to discover what differences, if any, exist between two groups of music students in (1) their ability to improve their sensitivity to errors of intonation and (2) their ability to recognize errors of intonation in triads and chords within the performing ensemble. The control group was exposed only to the traditional method of teaching intonation, and the experimental group was exposed to an experimental method of teaching intonation. The differences in learning, if any, would be shown by the results of a posttest administered to the two groups.

More specifically, the purpose of this investigation was to answer the following questions:

1. Is there a difference between the experimental and control groups in their ability to recognize errors of intonation?

2. Is there a difference between the two groups in their ability to recognize errors of intonation in the intervals of the major third, the minor third, the perfect fifth and the minor seventh?

3. Is there a difference between the two groups in their ability to recognize errors of intonation occurring in the major triad, the minor triad and the chord of the dominant seventh?

4. Is there a difference between the two groups in their ability to recognize the direction of intonation errors?

5. Is there a difference in the learning between the students who have a high score on the pretest and the students who have a low score on the pretest within the experimental group?

IMPORTANCE OF THE STUDY

The teaching of intonation usually centers about a discussion of perfect intervals and mathematical proportions of scales and intervals. This approach makes the student more aware of the problems of intonation, but he is not offered a solution to these problems.

It does not follow that since a performer of a musical instrument is able to control his intonation within the ensemble he is able as a conductor to control the problems of intonation within the ensemble under his baton. Maurice Gerow, in his review of Lawrence McQuerry's dissertation, states that it is only necessary to attend a number of secondary school concerts to be convinced that intonation is easier to discuss than it is to correct. (13)

Donald Stauffer, in his dissertation, presents strong evidence that performers with many years of experience do not adhere to any of the accepted temperaments when they perform out of the ensemble or without an ever present guide, such as, a keyboard instrument. In his analysis of the intonation used by performers on wind instruments he found the strongest tendencies were to tune pitches sharp to equal temperament. (8) The degree to which the performer tends to be sharp is not consistent from pitch to pitch or from octave to octave, thereby complicating the problem for the conductor.

Very similar results were found by A. W. Ahrens in his study of amateurs on several wind instruments. (16) Ahrens also found that

it is possible for the amateur while sustaining a pitch to vary it from sharp to flat very easily. Others have presented evidence showing that the performer is very flexible in his intonation habits. (1, 5, 6) This flexibility needs to be accurately controlled in performance.

Many music educators during recent years have stressed the need for identifying the skills necessary to the development of good musicians. Charles L. Spohn has stated that:

> Basic conflicts in music education are apparent since ultimate goals for music learning, as a rule, are not stated in specific terms that can be objectively evaluated. (15)

To correct this condition Spohn and his associates at The Ohio State University, and James C. Carlsen (12) and Walter R. Ihrke (14) at the University of Connecticut have launched an extensive program to identify the necessary aural skills needed by the musician. In addition, they have developed taped programs that guide the student to the now established goals.

The identified goals are the skills of rhythmic perception, aural perception, and oral reproduction of the printed page. These skills are of absolute necessity in the reading and reproduction of music. Taped programs have been highly developed, and they are continually being refined and improved upon. Dr. Carlsen has released an aural program commercially. (3)

Research indicates that there is a lack of studies concerning a vital discipline in the performance of music. This discipline is the ability to identify and to correct the intonation problems which ensue in the performing ensemble. Dr. Gerow isolates this problem very clearly:

> The ensemble tunes to "A" beautifully. But the music is in concert F, or G or B flat. What happens next is often painful. The teacher must take the blame for the out-of-tune chords that issue forth, but, was he trained to tune them, or even notice them? (13)

There is an indication that the student-conductor is not trained in intonation skills in a manner which isolates and offers a solution to the handling of intonation within the performing ensemble. A further indication is that the skill of identifying and correcting errors of intonation is absolutely necessary to the conductor of performing ensembles.

As a result of his study with an intonation training device, McQuerry recommended that:

> In addition to studies involving the actual presence of the ITD, uses could be developed employing recordings of the controlled tones produced by this instrument. Recordings could be made not only of deviations in the pitches of single tones, but deviations in intonation of chords and progressions. (17)

The present study incorporates these recommendations in the experimental instrument that was developed to help students to improve their ability to cope with intonation errors in their role as conductor.

METHODS AND PROCEDURES

The Experimental Design.

The experimental design selected for this study was the Nonequivalent Control Group Design as outlined by Campbell and Stanley. (2) This design is recommended when the experimental and control groups are naturally intact and when randomization is not possible. Although this is a quasi-experimental design, as opposed to a true experimental design, Campbell and Stanley state that, "This is one of the most widespread designs in educational research" (2) and although the subjects are not randomly assigned from a common population to experimental and control groups, this design is highly recommended by them when true experimental designs are not possible. The assignment of the experimental instrument to one intact group or the other is under the experimenter's control, and it was made randomly.

The Nonequivalent Control Group Design is illustrated in the diagram that follows in which the O's indicate observations, or tests, and the X's indicate the experimental treatment.

O_1 X O_2

O_3 O_4

Table I illustrates the sources of invalidity present in the Nonequivalent Control Group Design. The pluses (+) show that the factor has been controlled and the minuses (-) show no control. Where a question mark occurs, the degree of invalidity present in this design cannot be determined. In the event that control is

missing an effort must be made to modify procedures, where possible, to minimize the resulting invalidity.

A review of Table I shows that all of the sources of internal validity have been accounted for except selection--maturation interaction and the problem of regression cannot be predetermined. There are at least three threats to external validity which are not accounted for in the Nonequivalent Control Group Design.

The first problem of internal validity is that of selection-maturation interaction. This condition occurs when a differential rate of maturation obscures the effect of any treatment. Such a condition is inherent when the experimental and control groups are drawn from extremes within the population. This condition was avoided in the present study by involving two beginning conducting classes that are part of the regular program in music education.

The second threat to internal validity shown in Table I is that of regression. Campbell and Stanley refer to regression as, "the universal tendency of extreme scores to be closer to the mean on a second test." They further state that, "If either comparison group has been selected for its extreme scores on O or some other measure, then a difference in shift from pretest to posttest between the two groups may well be a product of regression rather than the effect of X." In this study, the pretest did not indicate that extreme scores would be a threat from either group, and since the comparison groups were not selected because of inherent extremes, the regression to the mean was considered in the analysis of the data from pretest to posttest.

The first of the threats to the external validity of the Nonequivalent Control Group Design is that of interaction of testing and treatment, and occurs when the pretest sensitizes the subjects to the treatments and, therefore, influences its effects. To lessen this effect the pretest was administered at the very beginning of the semester to appear as part of the normal procedure in the conducting class. As with all of the standard tests administered to these students, the pretest form was multilithed on good quality paper, and no unusual questions were asked of the students. No mention was made that the students were participating in an experimental study. Thus, the threat posed to external validity by interaction of testing and treatment is assumed to be negligible.

Interaction of selection and treatment is the second threat to external validity shown in Table I. This interaction occurs when selection of subjects is drawn from a population of volunteers. Since volunteers from a population are likely to differ in some aspects that may have an effect on the outcomes of the experiment, the outcomes

TABLE I.

SOURCES OF INVALIDITY IN THE NONEQUIVALENT CONTROL GROUP DESIGN*

Sources of Invalidity	Control
Internal Factors	
History	+
Maturation	+
Testing	+
Instrument	+
Regression	?
Selection	+
Mortality	+
Interaction of Selection and Maturation	-
External Factors	
Interaction of Testing and X	-
Interacting of Selection and X	?
Reactive Arrangements	?

*Adapted from Donald T. Campbell and Julian C. Stanley, "Experimental and Quasi-Experimental Designs for Research on Teaching," Handbook on Research in Teaching, N. L. Gage, editor (Chicago: Rand McNally and Company, 1963).

would be nonrepresentative of the total population, and therefore, it would be difficult to generalize. In this study, the classes represented were selected because the discipline being treated in the experiment logically became a part of the regular class work. The experimental group was selected by the researcher. The threat to external validity by interaction of selection and treatment is assumed to be negligible.

The last threat to external validity shown in Table I is that of reactive arrangements. Such a threat occurs when subjects are aware that they are participating in an experiment and their behavior is adjusted accordingly. Campbell and Stanley make several suggestions to avoid reactive arrangements. The first is to have the X's be usual classroom events occurring at plausible times. In this study, the learning tapes were a part of the regular class work, however, the student was required to work the experimental material outside of the classroom. A second suggestion was to make the O's a regular examination in the classroom routine. This was possible to do in the present study. Their third suggestion was to use the complete class as the experimental group rather then to randomize a portion of the class and to send them to another area to be tested. In this study, one of the conducting classes was designated as the experimental group. Inasmuch as it was not possible for the students to work with the experimental tapes during class time as part of their regular classroom work, the writer sees this as a limitation to the study.

Every effort was made to reduce the experimental nature of the study. Little or no mention of the experiment was made by the writer or the classroom teacher during this experiment. All of the material that the students handled, that is, the pretest/posttest answer sheet, the handbook, and the labels on the tapes were titled The Improvement of Sensitivity to and the Adjustment of Intonation in the Ensemble. This was an attempt to divert the student's attention from the experimental qualities of the study, and to create the impression that the materials were a portion of the regular class assignments.

Treatment of the Data.

The data collected on the pretest instrument were analyzed by an analysis of variance to ascertain that the groups were equalized groups, consequently the data collected on the posttest were also analyzed by an analysis of variance to reveal errors, kinds of errors, and the direction of errors. The errors of subjects in the experimental group classified as high and low on the pretest were also analyzed as to differences.

The successful employment of the analysis of variance technique depends on four assumptions. These assumptions are defined by Lindquist as follows:

1. All treatment groups were originally drawn from the same parent population.

2. The variance of criterion measures is the same.

3. The distribution of the criterion measures for each treatment population is normal.

4. The mean of the criterion measures is the same for each treatment population. (7)

Tate concurs with Lindquist that such assumptions must underlie the use of the analysis of variance, nevertheless, he emphatically states that the analysis of variance method is a powerful a statistical tool as an experimenter can have. (9) He and several authorities in educational measurement maintain that although all of the underlying assumptions are not strictly met the researcher who uses the analysis of variance technique can reasonably expect the results to be acceptable. Lindquist, Wert, Neidt, and Ahmann, (10) Edwards (4), and Winer (11) are among those who have taken this position.

According to Box, (11) when the groups to be compared are of unequal size, the assumptions of homogeneity of variance and normality of distribution as they relate to the analysis of variance are not of great importance and they can be neglected when testing for differences between group means. For this reason, there were two subjects randomly eliminated from the experimental group of twenty so as to equal the eighteen in the control group.

Chi square analysis was used to compare the frequencies of kinds of errors, that is, sharp and flat errors, for the experimental and control groups. The chi square test was used for this portion of the analysis because the data involved frequency categories and the categories were independent entities.

The Sample.

The sample for this study consisted of thirty-eight students who were enrolled in conducting classes during the second semester of the 1967-1968 school year at Arizona State University. There were twenty in the experimental group and eighteen in the control group.

Of the twenty in the experimental group, eleven were male and

nine were female. This group of students had a wide range of performing instruments as their major interest. Five listed their performing medium as voice; four as piano; two each as trumpet, trombone, French horn, and violin; and one each as percussion, clarinet, and bass. They also had a wide range of completed music theory sections. Two students had no formal theory classes, nine had completed one semester of theory, five had completed three semesters, and four had completed four semesters of theory classes.

Of the eighteen in the control group, six were male and twelve were female. As in the experimental group, there was a wide range of theory background. One student had completed five semesters and one had completed only one semester of class theory. Four indicated completion of two semesters, four of three semesters, and eight had completed four semesters of class theory. Major instrument study for students in the control group included eleven voice majors, three pianists, one organist, and one each majoring on flute, saxophone, and trumpet.

The Plan for the Experimental Instrument.

The plan for the experimental instrument was generated by the hypothesis that: experience in listening to prerecorded intervals, triads, and chords with controlled out-of-tune pitches continually compared to in-tune pitches would increase the sensitivity of a subject to errors of intonation.

To test the hypothesis, a training-testing situation was devised in which the subject could hear and compare pitch deviations of the tones on specified intervals.

A training-testing situation was organized that would provide the conditions described in the hypothesis, and an instrument had to be developed according to the following specifications:

1. It had to have recorded the required intervals, triads, and chords.

2. It had to have recorded the variations of pitch as prescribed.

3. It had to be sequenced from the easy to the complex.

Seventeen prepared magnetic tapes contained the material that was used in the experimental method. Recorded on the tapes were: (1) major thirds performed sharp and flat to an in tune equal tempered third; (2) minor thirds performed sharp and flat to an in tune equal

tempered minor third; (3) fifths performed sharp and flat to an in tune equal tempered perfect fifth; (4) major triads with sharp and flat major thirds within an equal tempered fifth, and sharp and flat fifths above an equal tempered major third; (5) minor triads treated in the same manner as major triads described in number 4; (6) dominant seventh chords treated as in number 4 with the addition of the minor seventh performed sharp and flat to an in tune equal tempered minor seventh; and (7) I-V_7, i-V_7, V_7-i, and V_7-I cadences with errors of intonation in each voice above the root to in tune equal tempered chords. In addition there were eight test tapes including the pretest/posttest tape.

The Taped Program.

Part One of the experimental method was concerned with the improvement of sensitivity to major thirds. A series of interval sensitivity training sequences were developed.

The major third, D - F sharp, was recorded on magnetic tape in the following manner:

The root pitch D was sounded for six counts, at the quarter note equal to seventy-six beats per minute, and it was followed by an in-tune equal tempered F sharp. This was followed by the root pitch sounding for six counts with a 25-cent-sharp-F-sharp sounding above the root after a two count rest. (See Appendix B)

This procedure was used for the remainder of the interval training sequences. A StroboConn was used to determine the exact frequency of all of the pitches.

Six levels of sharp major thirds were introduced; they were: (1) 25 cents sharp, (2) 16 cents sharp, (3) 10 cents sharp, (4) 8 cents sharp, (5) 6 cents sharp, and (6) 4 cents sharp.

Tape 1B used the same discrepancies and procedures followed with the major third flat to the root pitch. The complete cycle was repeated for the teaching of sensitivity to the intervals of the minor third and the fifth.

At the completion of this and subsequent parts of the experiment a unit test was administered. Each test was constructed with examples from the tape of that part.

Part Two of the experimental method was concerned with the improvement of sensitivity to minor thirds. This portion of the training sequence was carried out in the same manner as in Part One with

a series of discrepancies sharp to equal temperament, and a series of discrepancies flat to equal temperament.

Part Three of the experimental method followed the same procedure for the fifth.

Part Four of the experimental method was concerned with the improvement of sensitivity to the major triad. The major triad, D - F sharp - A, was recorded on magnetic tape as shown in Appendix B, page B-16.

Part 4A of the training tapes treated the major triad with errors sharp and flat in the major third compared to equal temperament. Part 4B treated the major triad with errors, sharp and flat, in the fifth compared to equal temperament. The errors of intonation were the same as those outlined for the tapes in Part One of the training sequence.

Part Five of the experimental method was concerned with the improvement of sensitivity to the intonation of the minor triad. The minor triad, D - F - A, was recorded on the magnetic tape. Tapes 5A and 5B were prepared in the same manner as outlined for the tapes in Part Four.

Part Six of the experimental method was concerned with the improvement of sensitivity to the intonation of the dominant seventh chord. The dominant seventh chord, A - E - C sharp - G, was recorded on magnetic tape. Part 6A of the training tape treated the minor seventh in the dominant seventh chord sharp to equal temperament. Part 6B treated the minor seventh flat compared to equal temperament.

Part Seven of the experimental method applied all of the intonation problems to the following cadences: I-V_7, i-V_7, V_7-I, and V_7-i. The string quartet and the woodwind quartet were used in the preparation of the tapes.

MAKING THE TAPES

Equipment Used.

All of the recordings were made in the studios at Audio Recorders in Phoenix, Arizona, under the supervision of a professional recording technician. The recordings were made on an Ampex #350, full track monaural tape recorder in conjunction with Telefunken U-47 microphones. Scotch Brand 201, 1-1/2 mil acetate tape was used for

the recordings. See Appendix E for equipment specifications.

The music was recorded at fifteen inches per second, and to insure pitch accuracy from reel to reel and from session to session the following equipment was employed: (1) a 100 cycle high pass filter, (2) 2,100 feet of tape was used to build a larger center to receive the recorded tape, and (3) an audio-oscillator. An Ampex alignment tape #01-31311-01 was used to adjust the recording and the play back level to the amplitude agreed on for the recordings.

Copies of the recordings were made on a Viking tape duplicator using a 2 to 1 speed ratio to reproduce tapes that played at 7-1/2 inches per second. The copies available for classroom use are on five-inch reels with three-inch centers.

In addition to the equipment used for recording the music, a StroboConn and two Strobotuners were employed to accurately vary the pitches as required for building the tapes. A Cadencia Palmer pocket metronome was used to insure that all of the recording was done at weventy-six beats per minute.

Building the Tapes.

A string quartet (two violins, viola, and cello) and a woodwind quartet (flute, oboe, clarinet, and bassoon) were used to make the tapes. These two ensembles were the New Art String Quartet and members of the Gammage Woodwind Quintet faculty-in-residence groups of Arizona State University. This approach of using live performers made it possible to incorporate the timbre of the instruments including their respective overtone series and the natural tuning conflicts that arise between pure intervals and equal tempered intervals.

Each interval, triad, and chord was recorded separately and correctly one time only. The musicians at all times, during the recording sessions, had a StroboConn or a Strobotuner in their full view which they constantly monitored. After each recording the material was played back and double checked with the strobe. Only when the pitches, and errors in pitch, were correct was the take accepted and marked as such.

The raw materials for the tapes included each needed interval, triad, and chord performed in-tune and all of the errors of intonation as required for this study. A conductor using the pocket metronome controlled all entrances of the instruments and the release of the instruments.

After all of the necessary intervals, triads, and chords were recorded the recording technician and the researcher began the process of dubbing and editing to prepare the individual tapes that contained the musical material that is illustrated in Appendix A. The same StroboConn that was used in recording the raw materials was used to double check the dubbing and the splicing of the sets of tapes. After each sound sequence was re-recorded, it was spliced in to form a continuous in tune - out of tune sequence. The sequence was then played back and checked on the strobe to insure accuracy.

The narrative material was prepared at the same time on one reel of tape. As the narration was needed, it was spliced into place.

Each tape was prepared in the following manner using the major third as an example:

1. The in tune interval was re-recorded twice, and checked with the strobe.

2. The out of tune interval was re-recorded three times, and checked with the strobe.

3. The pattern: narration, in tune, out of tune, out of tune, out of tune, and in tune were spliced in sequence, and set in the desired rhythmic pattern. Then the complete sequence was played back and all pitches were checked with the StroboConn.

4. Every sequence on each tape followed steps 1, 2, and 3.

As each set of sequences was completed the material was duplicated on a Viking duplicator on five-inch reels with three-inch centers. These reels were used to minimize pitch variation from the start of the reel to its end.

The material used for testing purposes was extracted from one of the duplicated reels and re-spliced in the needed sequence. The pretest/posttest was extracted from Tapes 7A and 7B. These included the cadences I-V, V7-I in major, and I-V7 and V7-I in minor. Errors were always in the second chord of the cadence. See Appendix C for a detailed description of the pretest/posttest.

PROCEDURE

The experimental group met as a class on Tuesdays and Thursdays, and they were required to work with the tapes daily outside of the classroom. The tapes and tape playback machines were available from the librarian in the music library. Students in this group were expected to work with the tapes from five to ten minutes daily and to work each set for one week. They were also cautioned to be sure that the playback machines were in proper working order. After working with the tape it was returned to the librarian.

The pretest was administered to the control group and to the experimental group on the same day within one hour of each other. A short verbal explanation of the plan of the test introduced the material.

This presentation included remarks about intonation errors, the need to identify the voice in which these errors occurred, the direction of the errors, and a written example of the cadences heard on the pretest tape. Three trial samples followed. The samples were discussed and then replayed. Each group then took the pretest.

A log of the time spent working with the tapes was to be kept by each student in the experimental group.

On Tuesday of each week, a unit test covering the previous week's assignment was administered to the experimental group. There were two interruptions in this schedule--the first was caused by the University cancelling classes on a Tuesday, and the second followed consecutively because of the Easter holidays. See Appendix D for a detailed description of the Unit Tests.

The posttest was administered to both the control and the experimental groups on the Thursday following the final unit test.

ANALYSIS OF THE DATA

Errors of intonation were analyzed to ascertain overall differences, specific differences, direction of differences, and group differences with respect to initial high and low achievers in the experimental group.

Errors in General

Errors of intonation were analyzed to ascertain overall differences between the experimental group and the control group with regard to all errors regardless of error direction, that is, sharp of flat.

Using the raw scores received on the posttest by the students, an analysis of variance was applied to determine the F value of the differences. The data cited in Table II show the test of significance with the posttest between the experimental and the control groups. The F value for the difference was determined to 1.00, and the F table indicated that 4.12 was needed to be significant at the .05 level of confidence. These results indicate that the mean scores for the experimental and control groups, shown in Table III, were not significantly different. See Appendix A for statistical tables.

Specific Errors

Specific errors of intonation were analyzed to determine differences between the experimental and control groups with regard to intervals of the major third, the minor third, the perfect fifth and the minor seventh as they occurred in the major triad, the minor triad, and the chord of the dominant seventh.

Analysis of variance of posttest scores for the major third, the minor third, the fifth, and the seventh, summarized in Table IV, exhibited no significant F values.

Using the raw scores received on the posttest by the students for the major triad, an analysis of variance was applied to determine the F value of the difference. The data cited in Table VI show the test of significance with the posttest between the experimental and the control groups for the major third and the fifth in the major triad. These scores indicate that the mean scores for the groups were not significantly different.

The raw scores received on the posttest for the minor triad by the students were applied to an analysis of variance to determine the F value of the difference. The data cited in Table VIII show the test of significance with the posttest between the experimental and control groups for the minor third and the fifth in the minor triad. These scores indicate that the mean scores for the groups, as shown in Table IX, were not significantly different.

An analysis of variance was applied to determine the F value of difference using the raw scores received on the posttest by students for the chord of the dominant seventh in major. The data cited in

Table X show the test of significance with the posttest between the experimental and control groups for the major third and the minor seventh in the chord of the dominant seventh. The F value for the difference is not significant at the .05 level of confidence; therefore, the mean scores between the groups are not significantly different.

Using the raw scores received on the posttest by the students for the chord of the dominant seventh in the tonic--dominant cadence in minor, an analysis of variance was applied to determine the F value of the difference. The data cited in Table XII show the test of significance with the posttest between the experimental and control groups for the major third and the minor seventh in the chord of the dominant seventh in the minor cadence. The F value for the difference was not significant. The mean scores for the groups as shown in Table XIII were, therefore, not significant.

Direction of Errors

The direction of errors of intonation were analyzed to ascertain differences between the experimental and control groups for the intervals in the major triad, the minor triad, and the chord of the dominant seventh as approached from the tonic major and the tonic minor triads.

The observed number of intonation errors identified in the major triad by the experimental and control groups, as shown in Table XIV, were used to compute the chi square of 1.35 for the total. The number of identified intonation errors in each category for the major third and the fifth were significantly low to warrant combining them into a total. In spite of this procedure the number of subjects who correctly identified all of the sharp and flat intonation errors on the third and the fifth was still too low. This category was eliminated in computing the chi square.

The computed chi square revealed a value for the difference to be 1.35 and the chi square table for two degrees of freedom at the .05 level of confidence to be 5.99; therefore, the null hypothesis that there is no significant difference between students in the experimental and control groups to identify the direction of intonation errors in the major triad could not be rejected.

The observed number of intonation errors identified in the minor triad by the experimental and control groups, as shown in Table XV, were used to compute the chi square of 1.01 for the total. The computed value for chi square revealed that the difference between the two groups was not significant.

Chi square was computed from the number of observed intonation errors identified in the chord of the dominant seventh as approached from the tonic major chord and as approached from the tonic minor chord. The computed chi square, as shown in Table XVI and in Table XVII, indicates that there is no significant difference between the two groups in this category.

High and Low

Errors of intonation were analyzed to determine if any difference existed between the subjects in the experimental group when classified as high and low, that is above or below the median of two, in their detection of errors on a pretest.

The data cited in Table XVIII show the test of significance with the posttest scores between the students in the experimental group who scored high on the pretest and the students who scored low on the pretest. The analysis of variance revealed an F value for the difference that was not significant at the .05 level of confidence. The mean scores for the high and low scoring students in the experimental group as shown in Table XIX were, therefore, not significantly different.

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The five questions were answered by testing null hypotheses reflecting each of the anticipated differences with respect to each question; that is, overall, or general differences in ability to detect errors, specific differences in ability to detect errors, differences in ability to detect errors in direction, and differences between subjects in the experimental group when classified as low and high in error detection on pretreatment instrument.

Question One

The first question to be answered was:

> Is there a difference between the experimental and control groups in their ability to recognize errors of intonation?

Findings. The analysis of variance of posttreatment scores for errors of intonation revealed that the F value was not significant at the 0.05 level; the mean scores for the experimental and control

groups were not significantly different.

Question Two

The second question to be answered by analysis was:

Is there a difference between the two groups in their ability to recognize errors of intonation in the intervals of the major third, the minor third, the fifth, and the minor seventh?

Findings. Analysis of variance of posttreatment scores for the major third, the minor third, the fifth, and the minor seventh exhibited no significant F values for the four variables. Consequently, the mean scores for each variable, major third, minor third, the fifth, and the minor seventh, were not significantly different.

Question Three

The third question to be answered by analysis was:

Is there a difference between the two groups in their ability to recognize errors of intonation occurring in the major triad, the minor triad, and the chord of the dominant seventh?

Findings. The analysis of variance of posttreatment scores for the major triad, the minor triad, and chord of the dominant seventh as approached from the major and minor triads exhibited no significant differences for the major third, the fifth, or the minor seventh; therefore, the mean scores were not significantly different.

Question Four.

The fourth question to be answered by analysis was:

Is there a difference between the two groups in their ability to recognize the direction of intonation errors?

Findings. Observation of the frequencies and computed chi square values revealed no significant differences between the experimental and control groups with regard to direction of errors.

Question Five

The fifth question to be answered by analysis was:

Is there a difference in the learning between the students who have a high score on the pretest and the students who have a low score on the pretest within the experimental group?

Findings. The analysis of variance revealed that the F value for the high and low groups was not significant at the 0.05 level; therefore, the mean scores for high and low were not significantly different.

Implications for Further Research

Although the results from this study did not indicate that the experimental method was more effective than the traditional method in the student's ability to judge errors of intonation, the reason may have been that the program was introduced too early or too late in the student's career. There is a possibility that the taped program was introduced at a point in the student's development when he could not take full advantage of the material. His listening habits and judgments related to intonation errors may be fixed, and it was not possible at this time to alter his decisions.

The student midway in his undergraduate studies may lack the motivation necessary to foresee his responsibility as a conductor to work diligently toward identifying intonation errors. After the student, as a teacher, has become fully aware of his inability to solve the intonation problems of his student ensembles he may use this taped program with more understanding. A more immediate need for assistance in this area could alter the findings.

Use of the experimental method in junior high school or the secondary school may indicate more positive results. At this time in the student's development he is becoming much more aware of the role that he plays in the tuning of the ensemble. Hopefully, he knows that the placement of his finger ona key of a wind instrument or the fingerboard of a string instrument does not guaranty in-tune performance. The motivation to improve his own performance and pride in his school ensembles could possibly alter the findings.

The experimental method may not have been significantly effective in improving intonation skills because the student was required to work with the experimental material outside of the classroom. This limitation was cited in the description of the experimental

design as a reactive arrangement that was a threat to the external validity of the experiment. Of the several controls applied, this condition was the only reactive arrangement that lacked complete control.

The possibility exists that different results might have been achieved if a teacher supervised all of the listening sessions. Each of the students would need to work at his own listening post with the tapes, and with a teacher present. This was not possible because of a limited number of tapes, lack of enough tape playback equipment, and limited space.

Another factor that may have contributed to the results of this study was the playback equipment used by the students. There is a possibility that playback equipment comparable to the Ampex recording equipment would alter the findings. Since the playback equipment did not reproduce the high quality of the tapes, there may have been distortion between the individual frequencies.

RECOMMENDATIONS FOR FURTHER RESEARCH

As a result of the observations made during the course of this study and the conclusions drawn from the study, the following recommendations are made for further study in the area of teaching intonation.

1. An investigation should be made at several academic levels to determine a more effective time in the musician's study to teach intonation judgment.

2. The controls that entered into the experimental design of this study did not allow an investigation into the most effective length and distribution of training time. A comparison could be made between the effectiveness of a short intensive training plan and that of an extended training plan.

3. Further research, with the method employed in this study, is recommended with students working during class time and at their own learning pace.

4. Another subsequent experiment would be an investigation of a method by which this individual training plan could be adapted for group instruction.

5. Further research could be done to determine the extent to which this approach to intonation study affects the student's ability to adjust his intonation on his performing instrument.

6. Research into the psychological aspects of the student as related to his ability to respond to errors of intonation is necessary to further understand the problems in this area.

7. Further research needs to be done to determine if the student-conductor who performs on his instrument with accurate intonation is more perceptive or less perceptive to intonation errors of other performers when he is acting as conductor. The recorded material in this study should be suitable for testing this ability.

8. Other methods employing aural and visual techniques to assist student-conductors need to be developed. Since results from this aural approach to improve the student's ability to recognize intonation errors was not superior to the traditional method, the question still remains as to how the ability to solve errors of intonation can be better developed.

9. Since the recording for this study used orchestral instruments, further research is recommended that would use voices and the stylistic intonations involved in choral materials.

10. Since this study was limited to the use of the major third, the minor third, the fifth, the minor seventh, the major triad, the minor triad, the chord of the diminant seventh, and the cadences possible with these chords, research involving other intervals, chords, or cadences would further clarify the effectiveness of this approach.

11. Additional research should be done, with this set of tapes, on playback equipment comparable to the Ampex recording equipment on which the tapes were prepared.

12. Although a relatively small sample was employed in this study, the investigation has provided data, previously unavailable, which appear to be significant in relation to the problem of improving intonation in musical performance. However, more research must be completed before the conclusions developed and presented in this writing can be accepted as being definitely conclusive.

SUMMARY

Research studies concerned with musical intonation show that in actual performance musicians do not adhere to any given temperament. More likely they adjust their pitch according to the tone quality that is desired. The literature clearly indicates that on wind instruments, which supposedly have fixed pitches, it is possible for the performer to raise or lower the pitch of the instrument to adjust quality and pitch in relation to the other instruments in the ensemble. The deviations in intonation are highly irregular, and they could not be adapted to any one temperament more then to any other because they do not follow any consistent pattern.

Since all wind and string instruments are very flexible, the responsibility to adjust his sound and to adjust his intonation to the demands of the ensemble lies with the performer. Further, the conductor-teacher should be fully aware of these conditions, and he has the responsibility to use this knowledge to improve the performance level of those with whom he works. However, research indicates that there is a lack of studies concerning the teaching of intonation skills.

McQuerrey developed a mechanical teaching device to help students to improve their sensitivity to intonation. The Intonation Tuning Device required the student to tune intervals by manipulating oscillator controls to match in-tune intervals; both directly at the controls and indirectly by instructing someone else to make the adjustments. His conclusions seemed to confirm that a mechanical approach to teaching intonation wes possible.

Studies conducted in the field during performances clearly indicate that intonation skills, both by the performer and the teacher-conductor, are seriously lacking. The need for new approaches and additional research in this discipline was responsible for the instrument developed for the present study and the implementation of this experiment.

The plan for the experimental instrument was generated by the hypothesis that: Experience in listening to prerecorded intervals, triads, and chords with controlled out-of-tune pitches continually compared to in-tune pitches would increase the sensitivity of a subject to errors of intonation.

The purpose of this study was to ascertain the difference in the ability of two groups of music students to improve their sensitivity to errors of intonation and to improve their ability to recognize the direction of intonation errors in triads and chords in the performing

ensemble. In particular, the study was limited to the development of sensitivity to the intonation of the major third, the minor third, the fifth, and the minor seventh, and to the development of sensitivity to the intonation of these intervals as they form the major triad, the minor triad, and the chord of the dominant seventh. A control group was exposed to the traditional method of teaching intonation, and the experimental group was exposed to an experimental method of teaching intonation.

Thirty-eight students, enrolled in two conducting classes at Arizona State University, were selected as the experimental and control groups. The Nonequivalent Control Group Design was selected as the experimental group, and eighteen subjects were in the control group. The experimental group was exposed to the experimental taped program to improve sensitivity to intonation, while the control group was exposed only to the traditional method of intonation study.

A pretest and posttest measured the kind of errors of intonation in the cadences of: I-V_7 and V_7-I in major and minor. The subject was required to: (1) recognize and to identify the voice in which the error took place, and (2) designate the direction of the error, that is, whether the error was sharp or flat in equal temperament. Errors were limited to twenty-five cents, sixteen cents, ten cents, eight cents, six cents, and four cents sharp and flat.

The subjects in the experimental group were exposed to the traditional method plus prerecorded magnetic tapes that aurally compared intonation errors with in-tune prototypes. The tapes included sensitivity training with major thirds performed sharp and flat to an in-tune equal tempered third; minor thirds performed sharp and flat to an in-tune equal tempered minor third; fifths performed sharp and flat to an in-tune equal tempered fifth; major triads with sharp and flat major thirds within an equal tempered fifth, and sharp and flat fifths above an equal tempered major third; minor triads treated in the same manner as major triads; dominant seventh chords with the minor seventh performed sharp and flat to an in-tune equal tempered minor seventh and the I-V_7 and V_7-I cadences in major and minor with errors of intonation in each voice above the root to in-tune equal tempered chords.

Errors of intonation were analyzed to determine overall differences, specific differences, direction of differences, and group differences with respect to initial high and low achievers in the experimental group. The statistical treatment for data involving direction of errors was chi square analysis. All other comparisons made use of analysis of variance.

The analysis of data revealed that no significant differences existed between the experimental and control groups in their ability to recognize errors of intonation. More specifically, there was no significant difference in the two groups to recognize intonation errors on the intervals of the major third, the minor third, the fifth, or the minor seventh, or intonation errors occurring in the major triad, the minor triad, or the chord of the dominant seventh. There was also no significant difference in the two groups to identify the direction of intonation errors, that is, errors that were flat and errors that were sharp.

In addition, there was no significant difference in the ability of the subjects in the experimental group to recognize intonation errors when classified as high and low ability on the basis of pretest data.

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GLOSSARY

GLOSSARY

Traditional method. This method is one by which intonation is treated on an individual basis in relation to the student's performing medium. This phase of his study is carried on at the individual's private lesson, his small and his large ensemble rehearsals and performances, conducting classes, and in his solo playing.

Cent. The cent is the unit of interval measure based upon the hundreth part of an equal tempered semitone and twelve hundred cents to the octave.

Sharp. A pitch in a given interval, triad, or chord will be sharp if the pitch sounds at a higher frequency than it should in equal temperament.

Flat. A pitch in a given interval, triad, or chord will be flat if the pitch sounds at a lower frequency than it should in equal temperament.

APPENDIX A

STATISTICAL TABLES

TABLE II

SUMMARY OF ANALYSIS OF VARIANCE OF POSTTEST SCORES
FOR EXPERIMENTAL AND CONTROL GROUPS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Groups	1	4.69	4.69	1.00
Within	34	160.06	4.71	
Total	35	164.75		

TABLE III

MEANS AND STANDARD DEVIATIONS OF POSTTEST SCORES
FOR EXPERIMENTAL AND CONTROL GROUPS

Statistic	Experimental	Control
Mean	4.06	4.78
Std. Dev.	2.55	1.70

TABLE IV

SUMMARY OF ANALYSIS OF VARIANCE OF POSTTEST SCORES ON M_3, m_3, 5TH, AND m_7

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
M_3				
Groups	1	1.78	1.78	1.10
Within	34	55.11	1.62	
Total	35	56.89		
m_3				
Groups	1	0.25	0.25	0.67
Within	34	12.72	0.37	
Total	35	12.97		
5TH				
Groups	1	1.78	1.78	1.88
Within	34	32.22	0.95	
Total	35	34.00		
m_7				
Groups	1	0.03	0.03	0.08
Within	34	12.72	0.37	
Total	35	12.75		

TABLE V

MEANS AND STANDARD DEVIATIONS OF POSTTEST SCORES ON M_3, m_3, 5TH, AND m_7 FOR THE EXPERIMENTAL AND CONTROL GROUPS

Statistic	Experimental	Control
M_3		
Mean	0.52	0.38
Std. Dev.	1.05	0.89
m_3		
Mean	0.12	0.17
Std. Dev.	0.38	0.42
5TH		
Mean	0.24	0.38
Std. Dev.	0.66	0.77
m_7		
Mean	0.12	0.14
Std. Dev.	0.33	0.44

TABLE VI

SUMMARY OF ANALYSIS OF VARIANCE OF SCORES ON THE M_3 AND 5TH FOR THE MAJOR TRIAD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
M_3				
Groups	1	0.25	0.25	0.81
Within	34	10.50	0.31	
Total	35	10.75		
5TH				
Groups	1	0.11	0.11	0.47
Within	34	7.89	0.23	
Total	35	8,00		

TABLE VII

MEANS AND STANDARD DEVIATIONS OF SCORES ON THE M_3 AND 5TH FOR THE MAJOR TRIAD FOR EXPERIMENTAL AND CONTROL GROUPS

Statistic	Experimental	Control
M_3		
Mean	0.10	0.16
Std. Dev.	0.31	0.41
5TH		
Mean	0.09	0.12
Std. Dev.	0.28	0.33

TABLE VIII

SUMMARY OF ANALYSIS OF VARIANCE OF SCORES ON THE M_3 AND 5TH FOR THE MINOR TRIAD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
m_3				
Groups	1	0.00	0.00	0.00
Within	34	10.88	0.32	
Total	35	10.88		
5TH				
Groups	1	2.25	2.25	3.81
Within	34	20.06	0.59	
Total	35	22.31		

TABLE IX

MEANS AND STANDARD DEVIATIONS OF SCORES ON THE m_3 AND 5TH FOR THE MINOR TRIAD FOR EXPERIMENTAL AND CONTROL GROUPS

Statistic	Experimental	Control
m_3		
Mean	0.14	0.14
Std. Dev.	0.39	0.35
5TH		
Mean	0.12	0.28
Std. Dev.	0.38	0.64

TABLE X

SUMMARY OF ANALYSIS OF VARIANCE OF SCORES ON THE M_3 AND m_7 OF I-V_7

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
M_3				
Groups	1	0.70	0.70	1.10
Within	34	21.61	0.64	
Total	35	22.31		
m_7				
Groups	1	0.11	0.11	0.61
Within	34	6.11	0.18	
Total	35	6.22		

TABLE XI

MEANS AND STANDARD DEVIATIONS FOR DIRECTION SCORES ON THE M_3 AND m_7 OF I-V_7

Statistic	Experimental	Control
M_3		
Mean	0.24	0.16
Std. Dev.	0.60	0.45
m_7		
Mean	0.05	0.09
Std. Dev.	0.22	0.28

TABLE XII

SUMMARY OF ANALYSIS OF VARIANCE OF SCORES ON THE M_3 AND m_7 of i-V_7

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
M_3				
Groups	1	0.25	0.25	0.68
Within	34	12.50	0.37	
Total	35	12.75		
m_7				
Groups	1	0.11	0.11	0.46
Within	34	8.11	0.24	
Total	35	8.22		

TABLE XIII

MEANS AND STANDARD DEVIATIONS FOR DIRECTION SCORES ON THE M_3 AND m_7 OF i-V_7

Statistic	Experimental	Control
M_3		
Mean	0.16	0.10
Std. Dev.	0.41	0.36
m_7		
Mean	0.09	0.05
Std. Dev.	0.28	0.29

TABLE XLV

SUMMARY OF CHI SQUARE ANALYSIS OF NUMBER OF MUSIC STUDENTS DETECTING DIRECTION OF ERRORS IN THE MAJOR TRIAD

Error	Experimental	Control	Total
M_3			
0	12	10	22
+	4	7	11
-	2	0	2
±	0	1	1
Total	18	18	36
5TH			
0	13	11	24
+	2	3	5
-	3	4	7
±	0	0	0
Total	18	18	36
Total			
0	25	21	46
+	6	10	16
-	5	4	9
±	0	1	1
Total	36	36	72

$\chi^2 = 1.35$ df = 2 $p > 0.05$

TABLE XV

SUMMARY OF CHI SQUARE ANALYSES OF NUMBER OF MUSIC STUDENTS DETECTING DIRECTION OF ERRORS IN THE MINOR TRIAD

Error	Experimental	Control	Total
m_3			
0	11	10	21
+	4	5	9
-	2	3	5
±	1	0	1
Total	18	18	36
5TH			
0	12	8	20
+	1	2	3
-	4	2	6
±	1	6	7
Total	18	18	36
Total			
0	23	18	41
+	5	7	12
-	6	5	11
±	2	6	8
Total	36	36	72

$\chi^2 = 1.01$ df = 2 $p > 0.05$

TABLE XVI

SUMMARY OF CHI SQUARE ANALYSIS OF NUMBER OF MUSIC STUDENTS DETECTING DIRECTION OF ERRORS FOR THE DOMINANT 7TH AS ASSOCIATED WITH THE MAJOR TRIAD

Error	Experimental	Control	Total
M_3			
0	9	11	20
-	14	9	23
+	0	0	0
±	0	0	0
Total	23	20	43
m_7			
0	15	13	28
-	3	3	6
+	0	2	2
±	0	0	0
Total	18	18	36
Total			
0	24	24	48
-	17	12	29
+	0	2	2
±	0	0	0
Total	41	38	79

$\chi^2 = 0.18$ df = 1 $p > 0.05$

TABLE XVII

SUMMARY OF CHI SQUARE ANALYSIS OF NUMBER OF MUSIC STUDENTS DETECTING DIRECTION OF ERRORS FOR THE DOMINANT 7TH AS ASSOCIATED WITH THE MINOR TRIAD

Error	Experimental	Control	Total
M_3			
0	10	13	23
−	9	6	15
+	0	0	0
±	0	0	0
Total	19	19	38
m_7			
0	15	13	28
−	3	3	6
+	0	2	2
±	0	0	0
Total	18	18	36
Total			
0	25	26	51
−	12	9	21
+	0	2	2
±	0	0	0
Total	37	37	74

$\chi^2 = 0.06$ df = 1 $p > 0.05$

TABLE XVIII

SUMMARY OF ANALYSIS OF VARIANCE OF POSTTEST SCORES FOR EXPERIMENTAL SUBJECTS CLASSIFIED AS HIGH AND LOW ON THE PRETEST

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Groups	1	1.25	1.25	0.16
Within	18	141.70	7.87	
Total	19	142.95		

TABLE XIX

MEANS AND STANDARD DEVIATIONS FOR POSTTEST SCORES OF EXPERIMENTAL SUBJECTS CLASSIFIED AS HIGH AND LOW ON THE PRETEST

Statistic	High	Low
Mean	4.30	3.80
Std. Dev.	2.67	2.94

APPENDIX B

STUDENT HANDBOOK

The Improvement of Sensitivity to and the Adjustment of Intonation in the Ensemble

By Ralph Rizzolo

This booklet is to be used in conjunction with the taped program entitled The Improvement of Sensitivity to and the Adjustment of Intonation in the Ensemble.

The taped program has been designed to assist you to develop a greater sensitivity to intonation. Intonation, as you are aware, is a very vital ingredient in the performance of music, and the ability to hear and to correct errors of intonation is a necessary skill for the conductor.

On the tapes are recorded intervals, chords and cadences performed in tune (in equal temperament) and with errors of intonation. The instruments used in preparing the tapes were the string quartet and the woodwind quartet. Instruments were used--rather than electronic synthesizers--to more nearly simulate actual playing conditions.

Deviations in intonation (sharp and flat) vary from 25 cents to 4 cents on the major third, the minor third, the fifth, the minor seventh, the major triad, the minor triad, the chord of the dominant seventh, the dominant to tonic cadence in major, the dominant to tonic cadence in minor, the tonic to dominant cadence in major and the tonic to dominant cadence in minor.

There are seven sets of tapes. The taped material will help you to improve your ability to hear errors of intonation. You will be helped to identify the voice in which the errors occur and the direction--sharp or flat--of the error.

All of the taped material is in written form on the following pages. Follow it closely as you work with the tapes. Very close listening will develop the skills necessary to identify errors of intonation.

INSTRUCTIONS

1. The tapes are available from the librarian, and they must be used in the library.

2. Each example begins with the interval, chord or cadence played in tune. This is followed by two or three samples of the interval, chord or cadence performed out of tune. Each example closes with the interval, chord or cadence in tune.

3. Follow the manuscript as you listen to the examples. In addition to helping you identify the interval, chord or cadence, you will be advised as to the degree and direction of deviation in intonation that is taking place.

4. Use the tapes in sequence. One set each week.

5. It is recommended that the tapes be used daily. Five to ten minutes is all that is required in listening time for each tape.

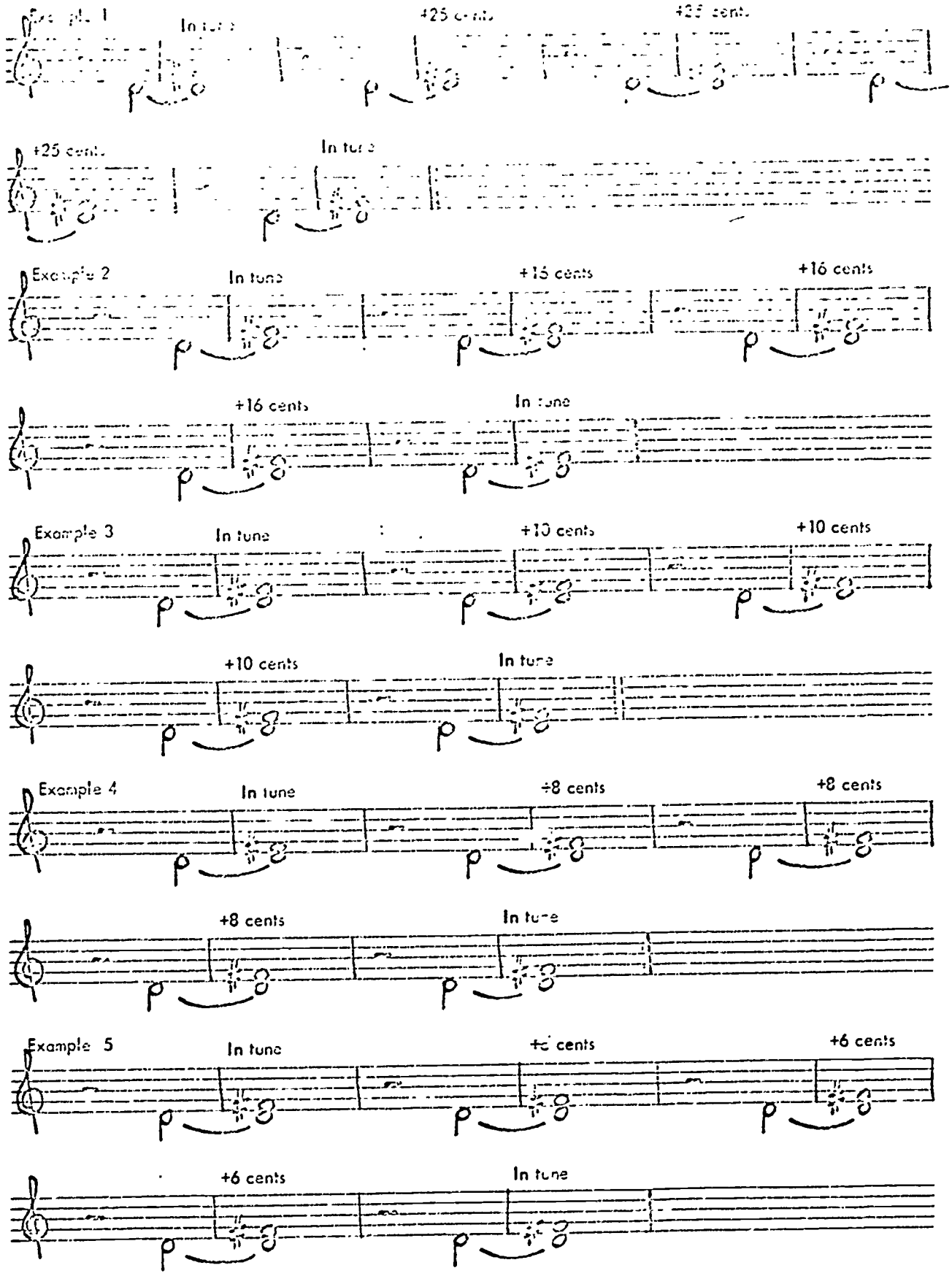
6. Keep an accurate log of the time that you work with the tapes. The log pages are at the back of this booklet.

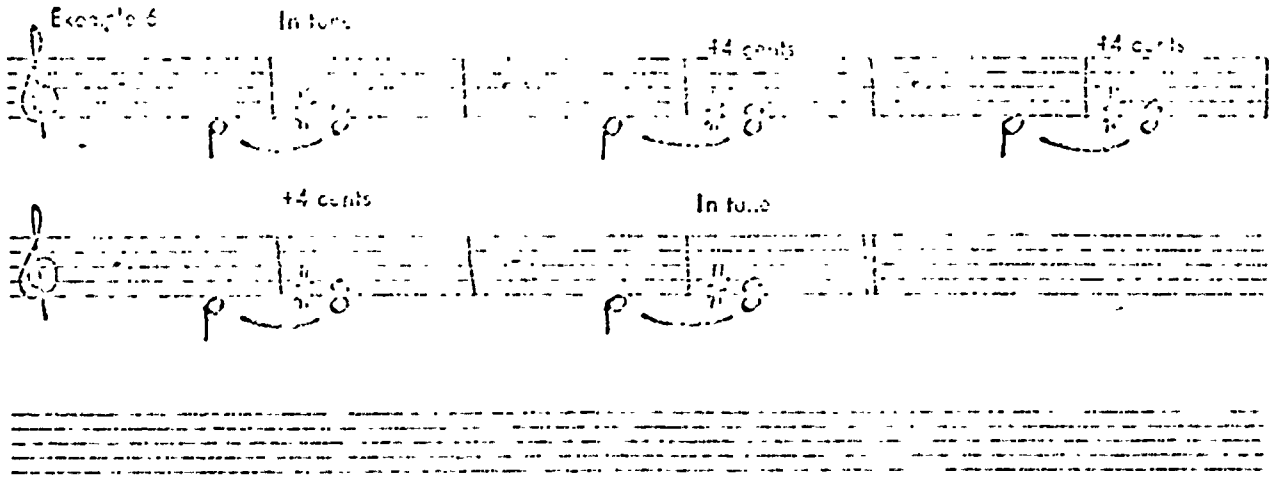
7. Be sure that the playback machine is in good working order.

8. Be sure that the earphones are adjusted properly and that they are in good operating order.

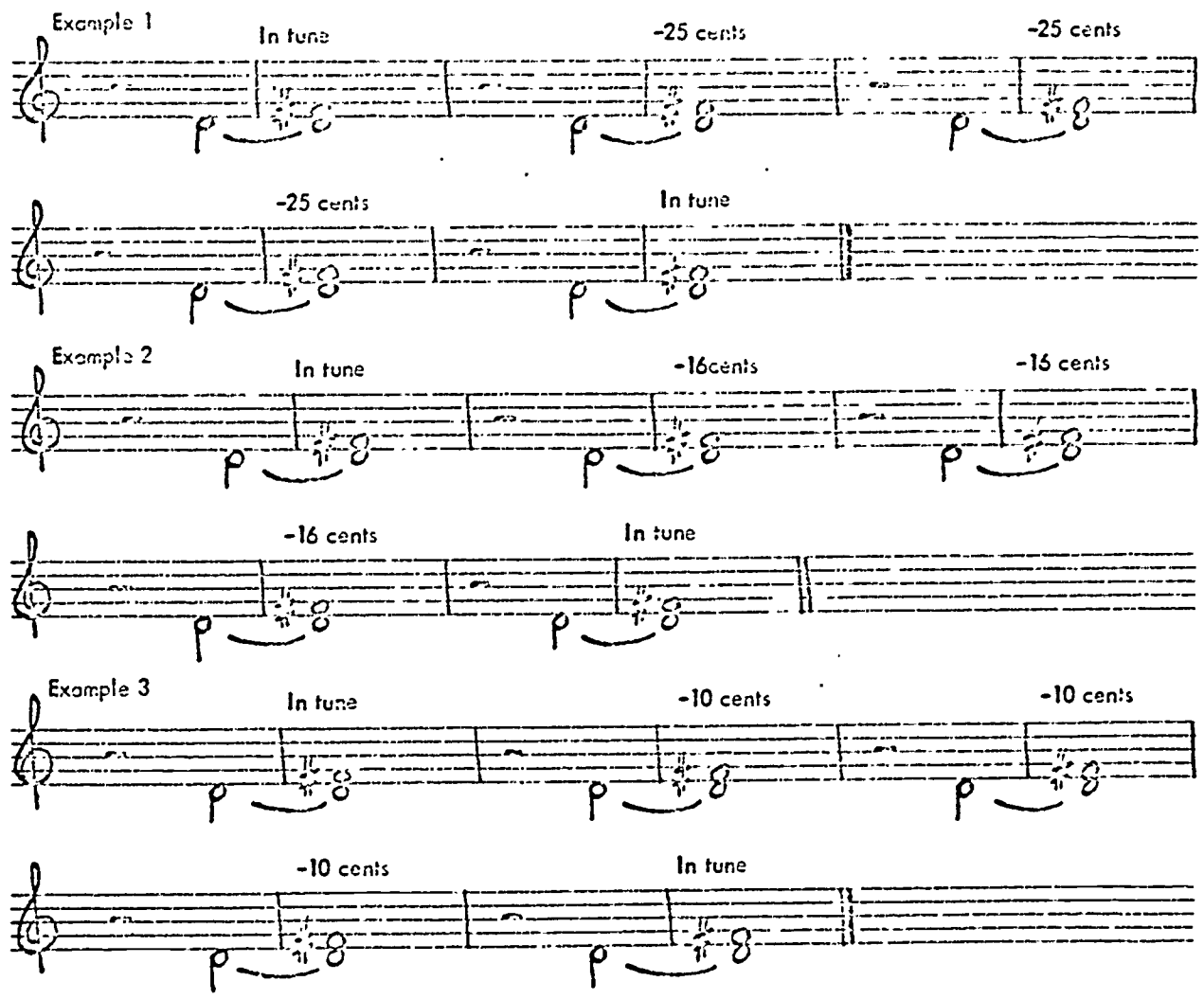
9. When you have finished using the tape please rewind it, and return the tape to the librarian.

TAPE 1A: [illegible]


Example 1
In tune
+25 cents
+25 cents
+25 cents
In tune
Example 2
In tune
+16 cents
+16 cents
+16 cents
In tune
Example 3
In tune
+10 cents
+10 cents
+10 cents
In tune
Example 4
In tune
+8 cents
+8 cents
+8 cents
In tune
Example 5
In tune
+6 cents
+6 cents
+6 cents
In tune



TAPE 18: Major thirds flat in equal temperament



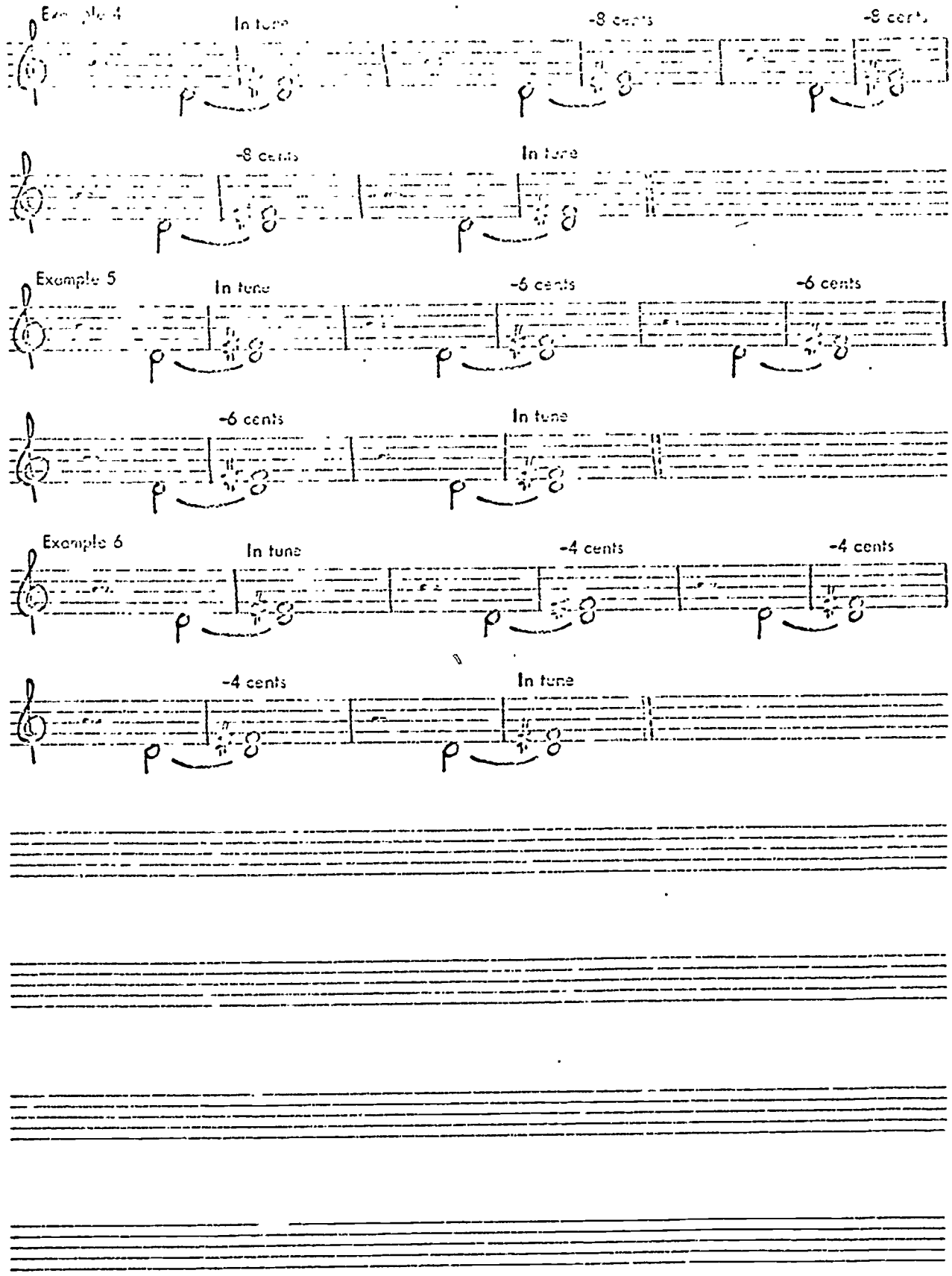
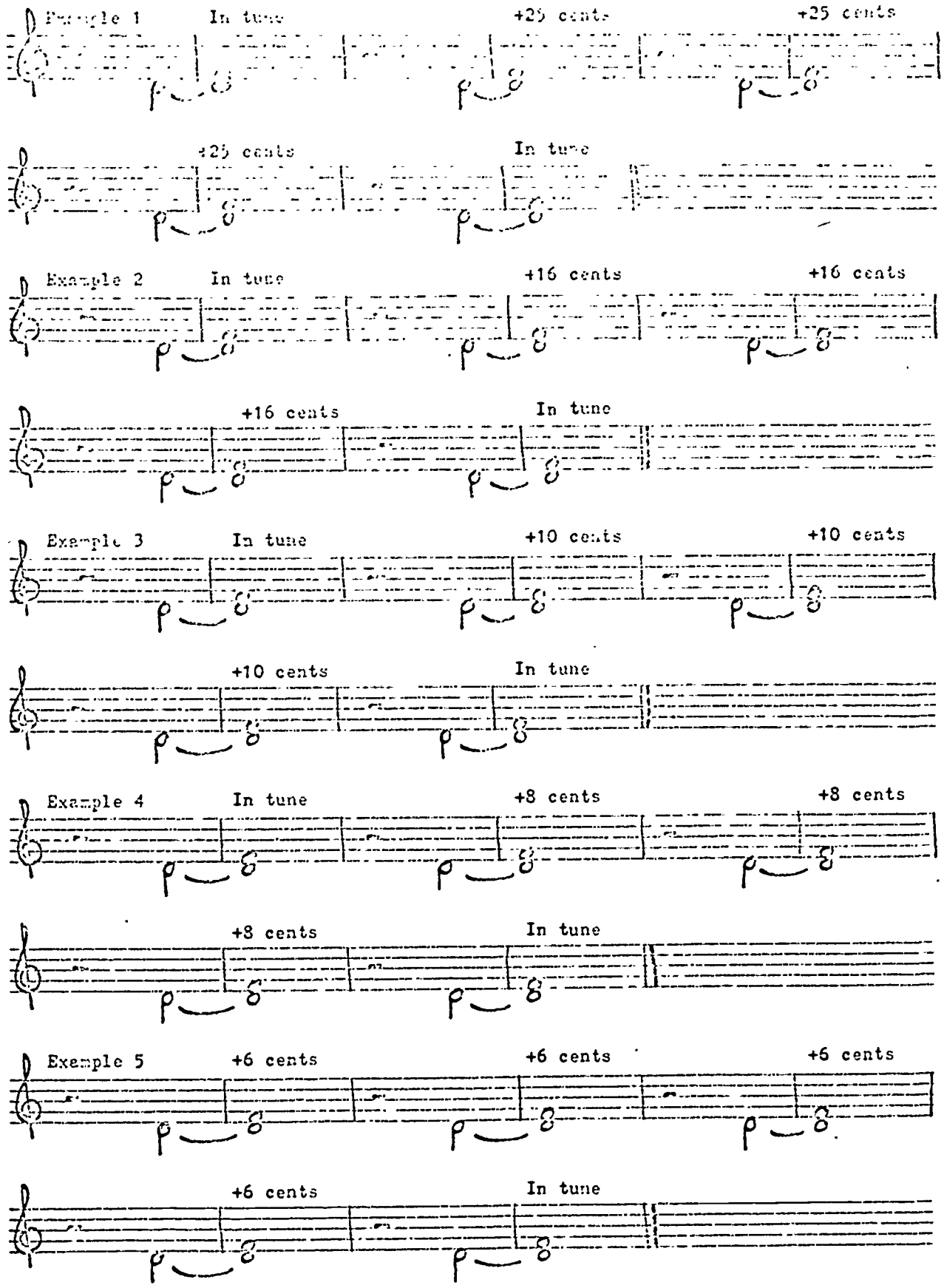
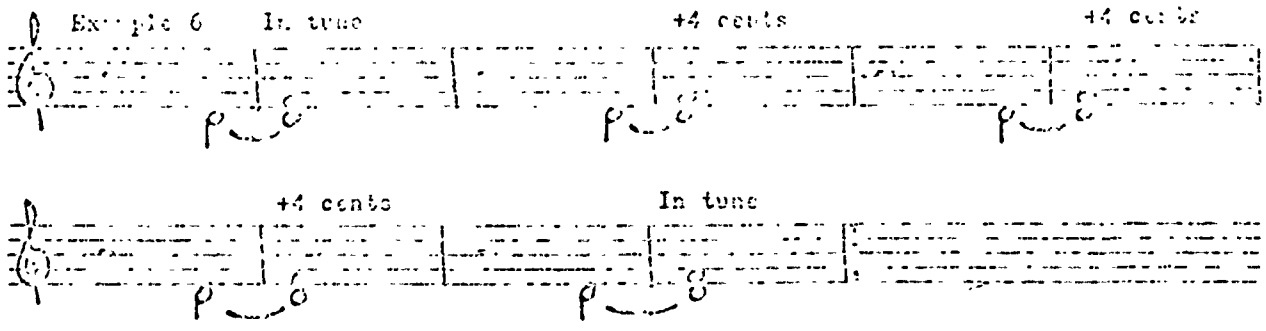
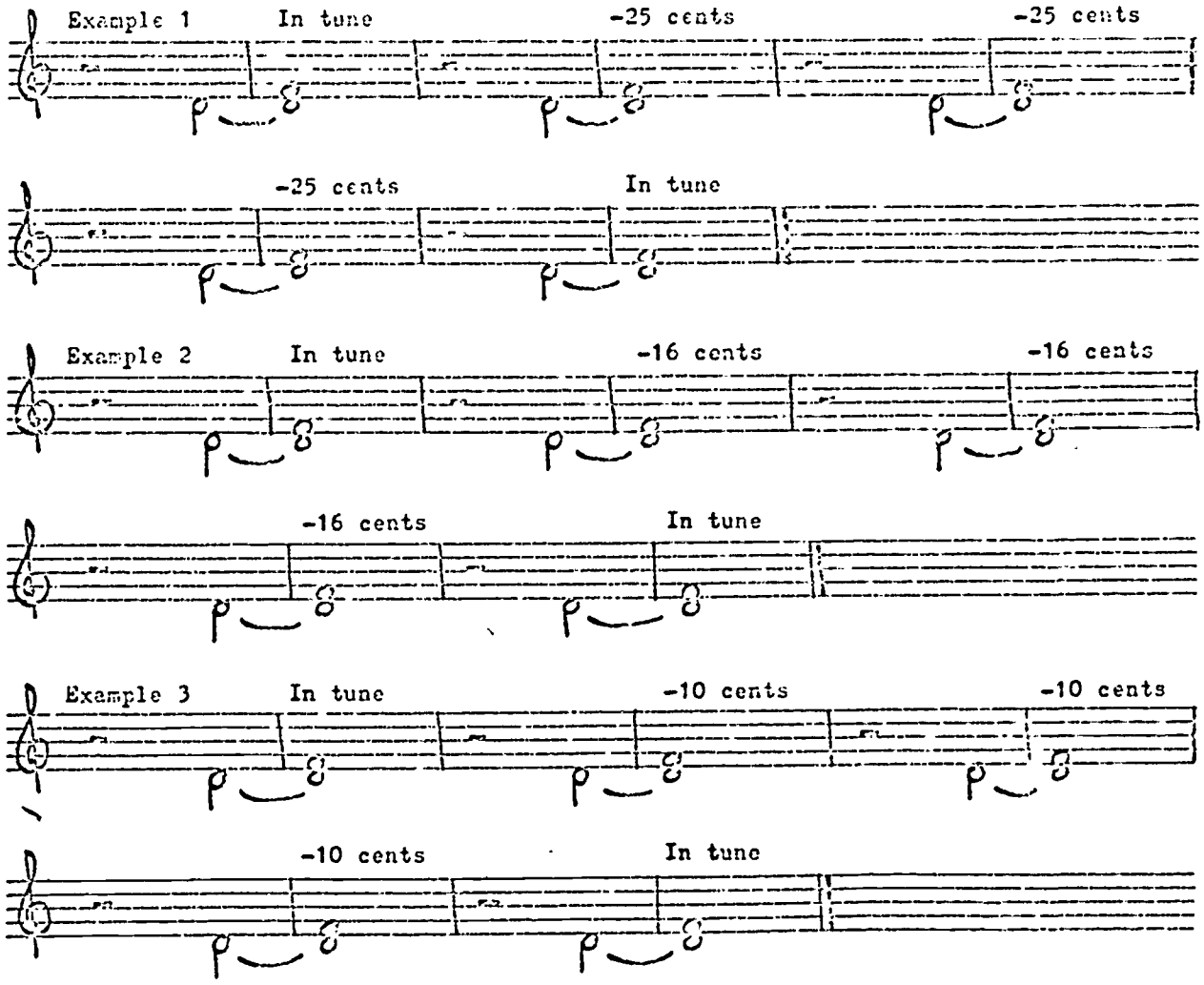

Example 4
In tune
-8 cents
-8 cents
-8 cents
In tune
Example 5
In tune
-6 cents
-6 cents
-6 cents
In tune
Example 6
In tune
-4 cents
-4 cents
-4 cents
In tune

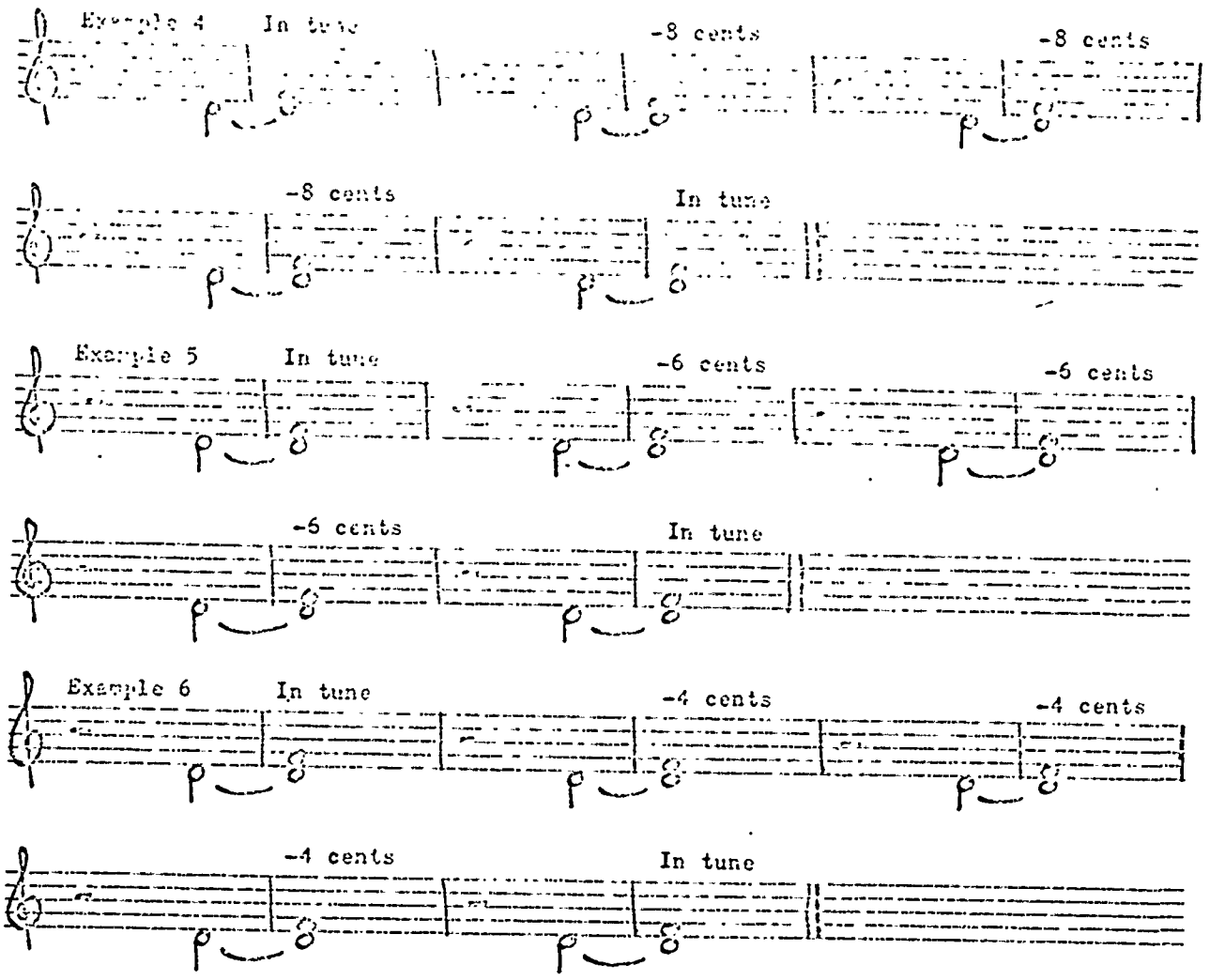
TABLE 2A: Minor thirds sharp in equal tempered art



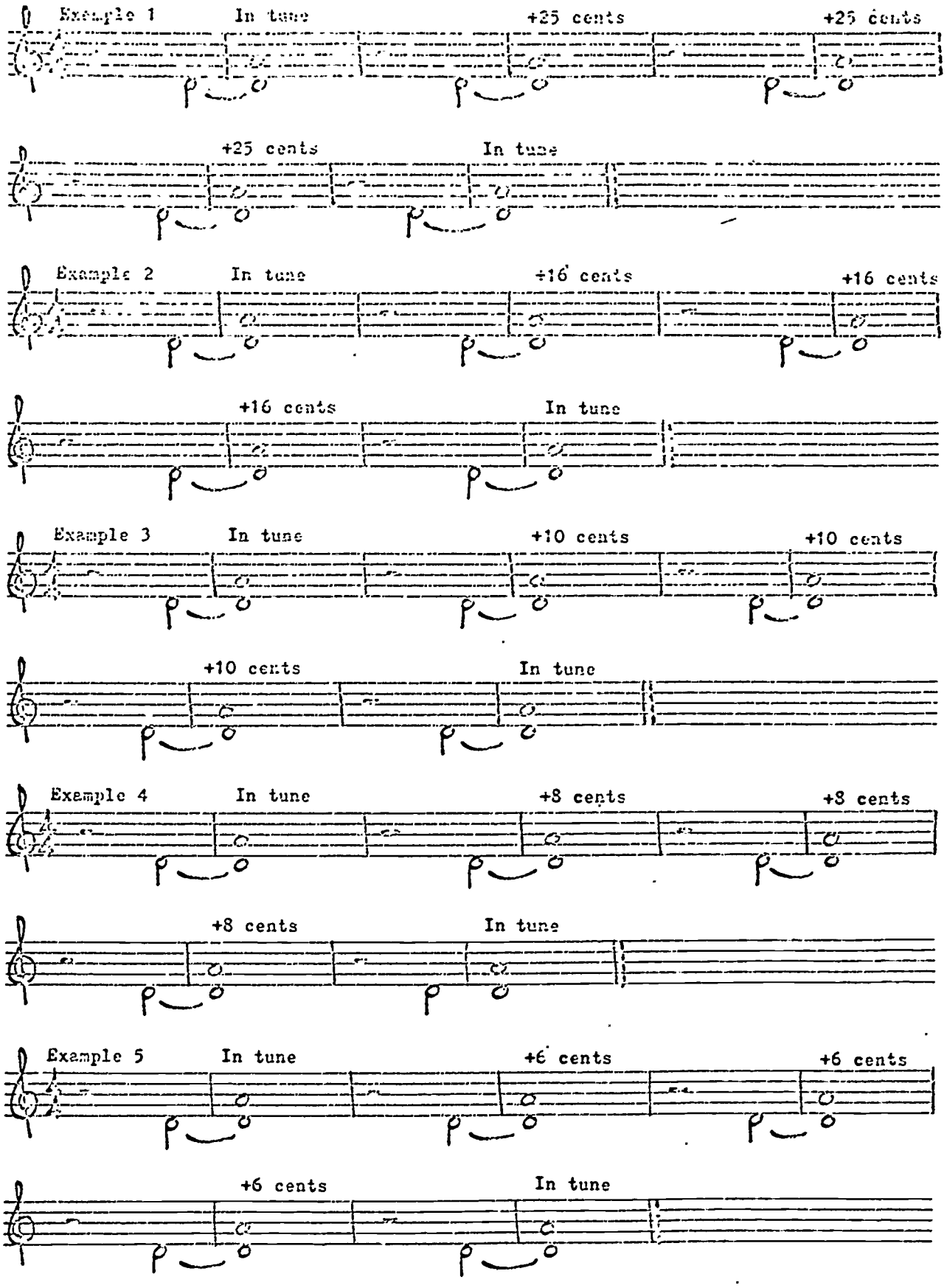


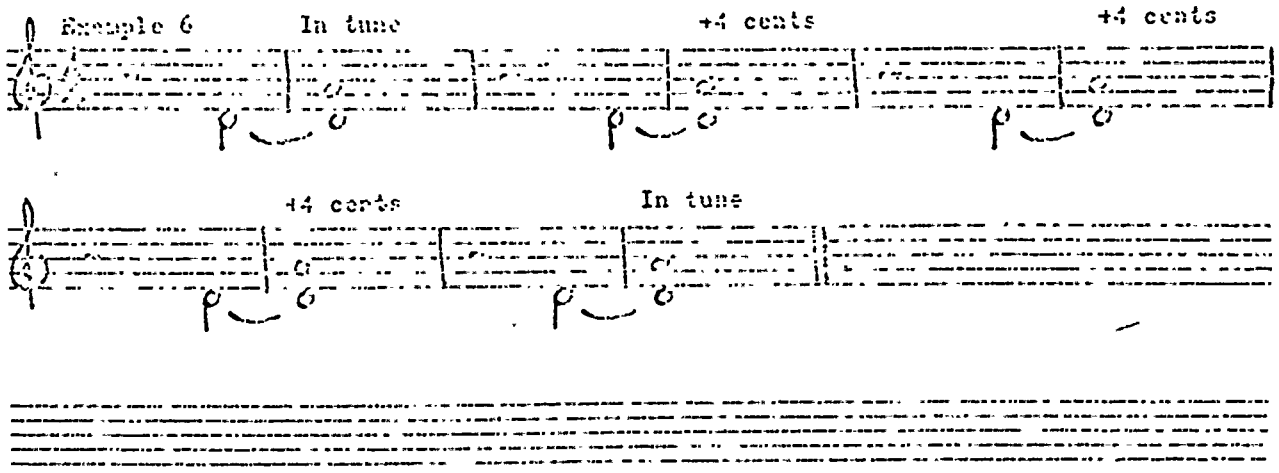
TAPE 2B: Minor thirds flat in equal temperament



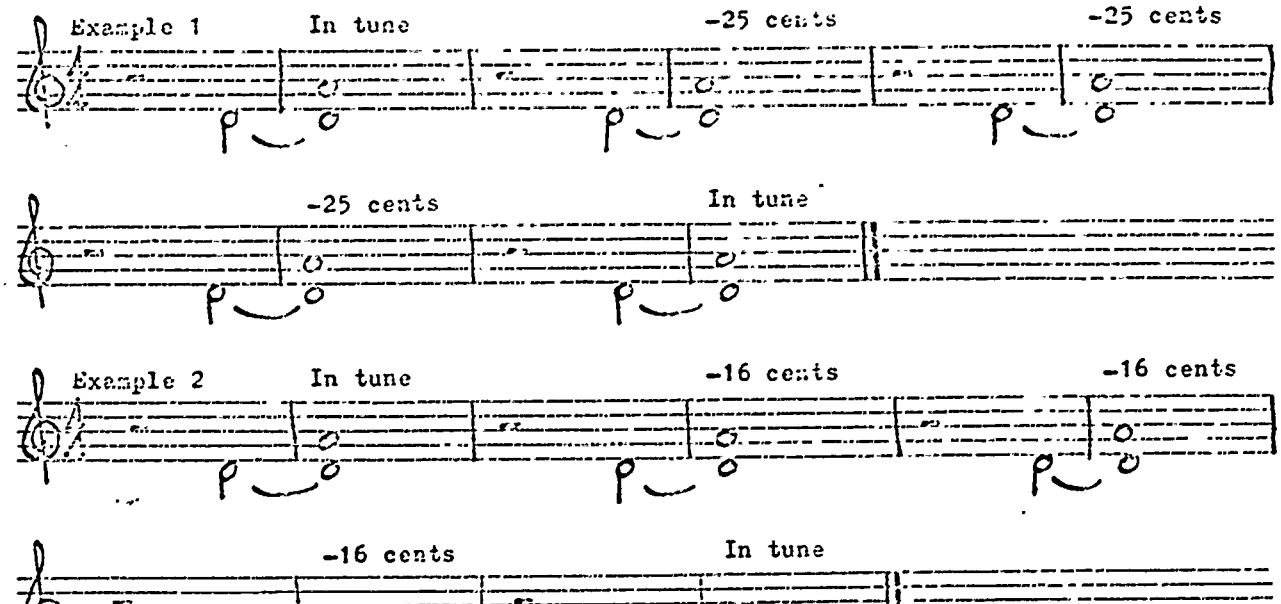

Example 4
In tune
-8 cents
-8 cents
-8 cents
In tune
Example 5
In tune
-6 cents
-6 cents
-6 cents
In tune
Example 6
In tune
-4 cents
-4 cents
-4 cents
In tune

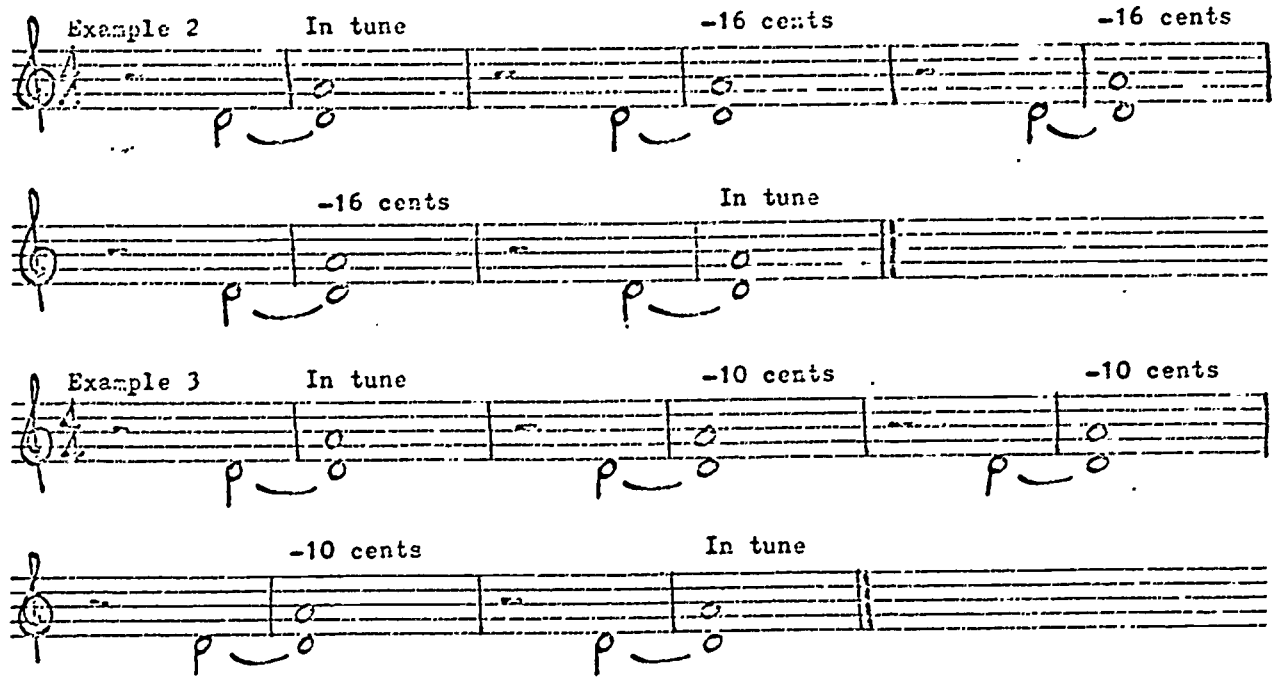
TAPE 3A: The interval of a fifth with the fifth sharp to the root pitch

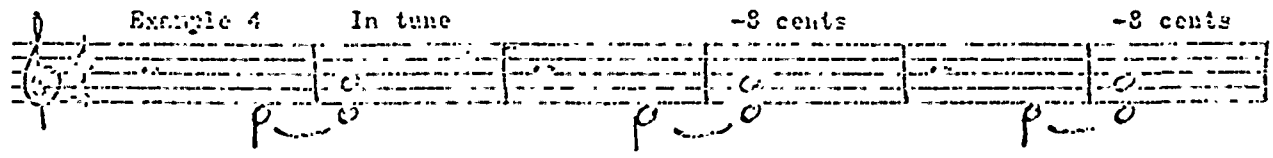


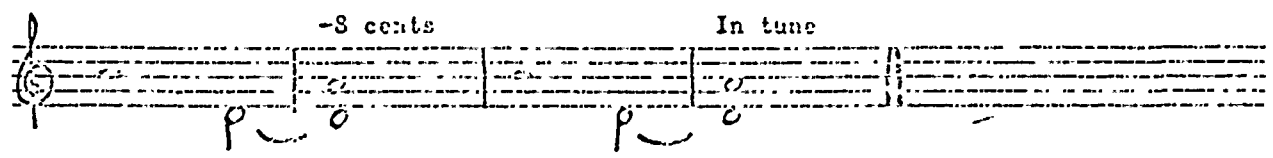


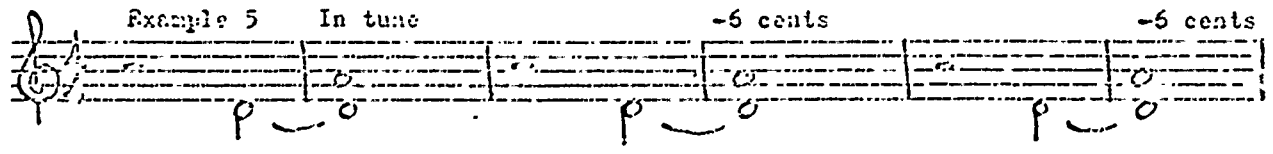
TAPE 3B: The interval of a fifth with the fifth flat to the root pitch

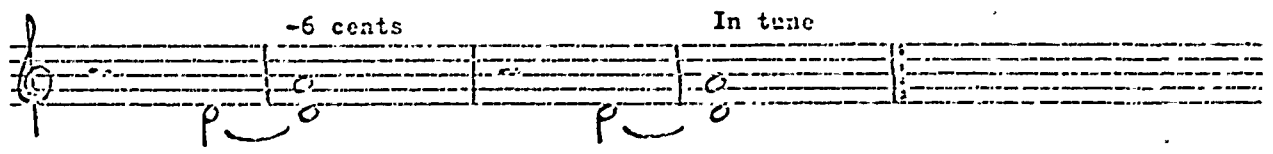


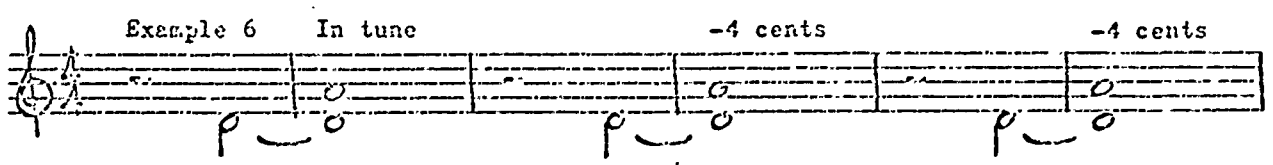


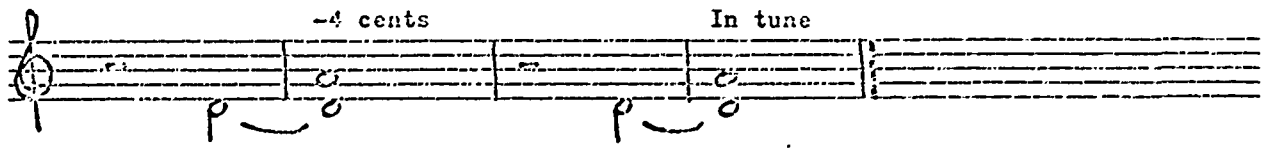

Example 4
In tune
-8 cents
-8 cents


-8 cents
In tune

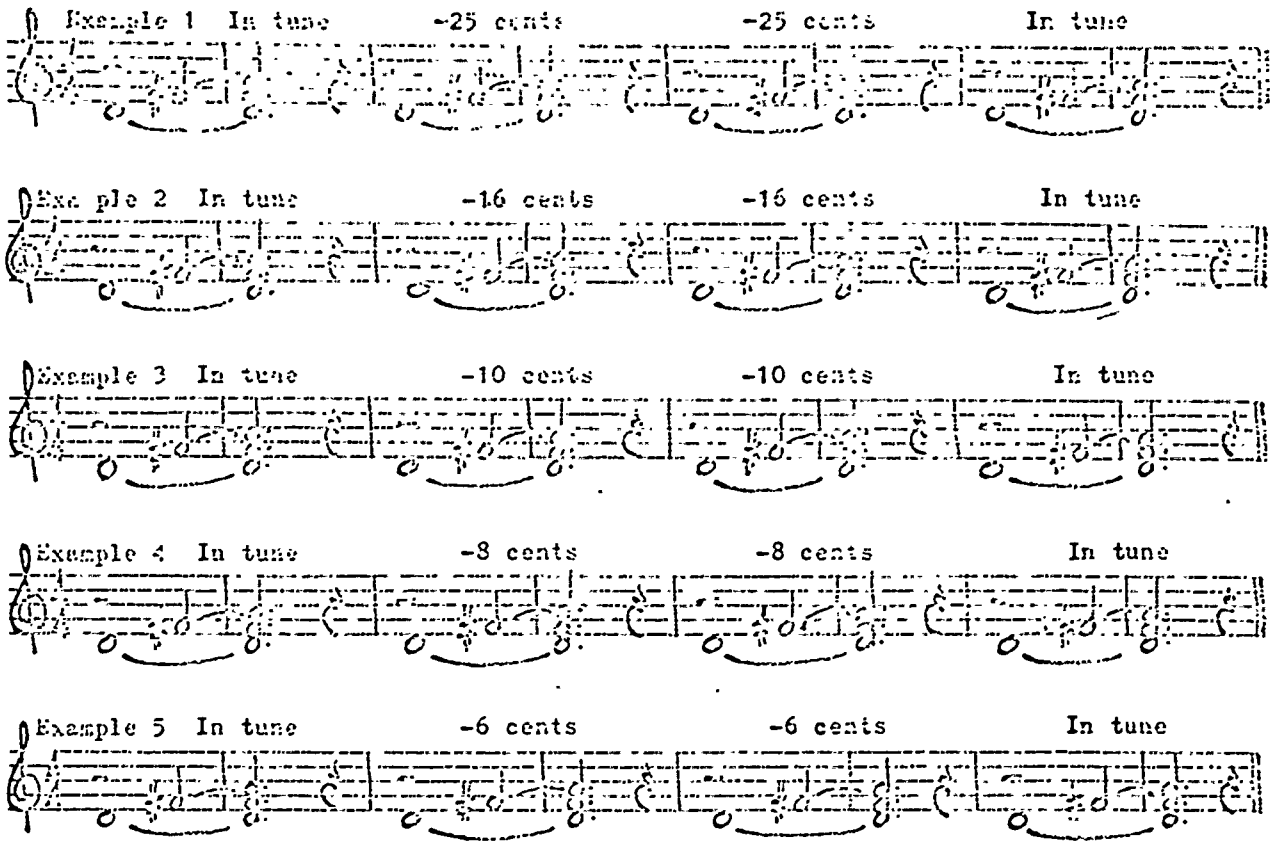

Example 5
In tune
-6 cents
-6 cents


-6 cents
In tune

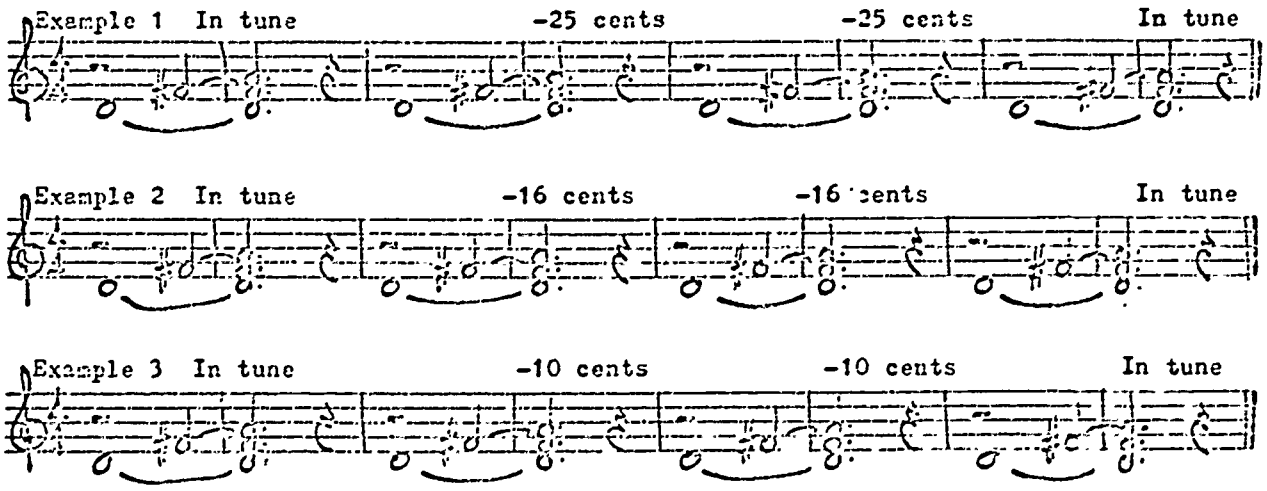

Example 6
In tune
-4 cents
-4 cents


-4 cents
In tune

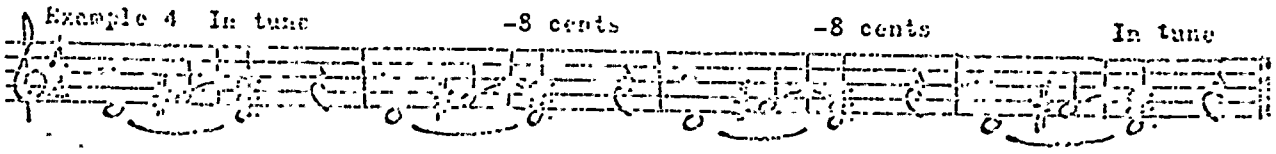
TAPE 4A: Major triads in equal temperament with the major thirds flat, Part II



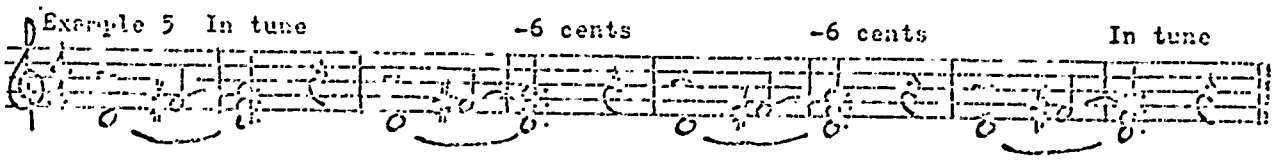
TAPE 4B: Part II, Major triads in equal temperament with the fifths flat



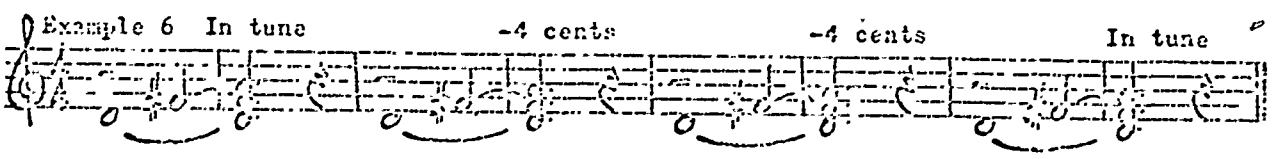
Example 4 In tune -8 cents -8 cents In tune



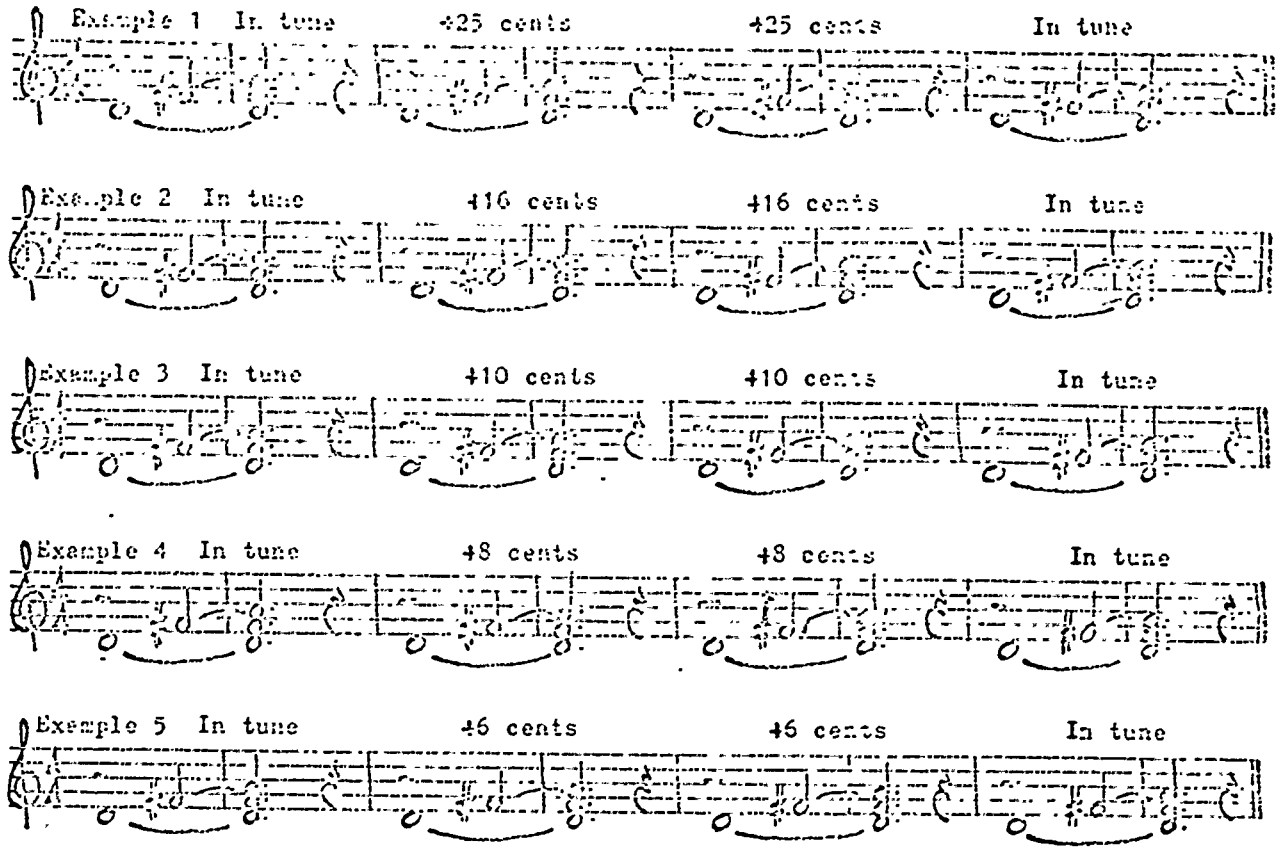
Example 5 In tune -6 cents -6 cents In tune



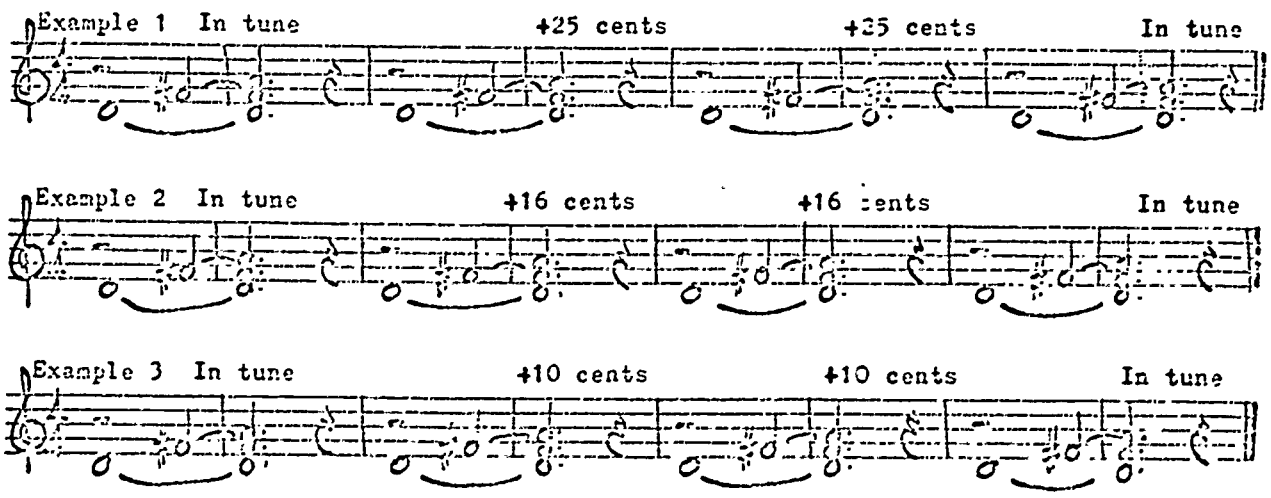
Example 6 In tune -4 cents -4 cents In tune

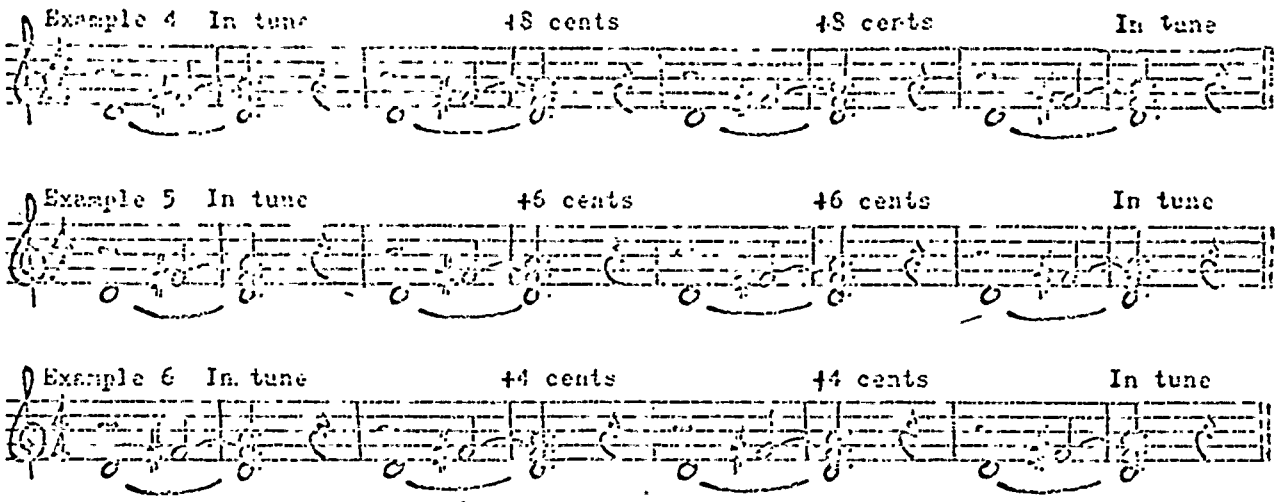


TAPE 4A: Major triads in equal temperament with the major thirds sharp, Part 1.

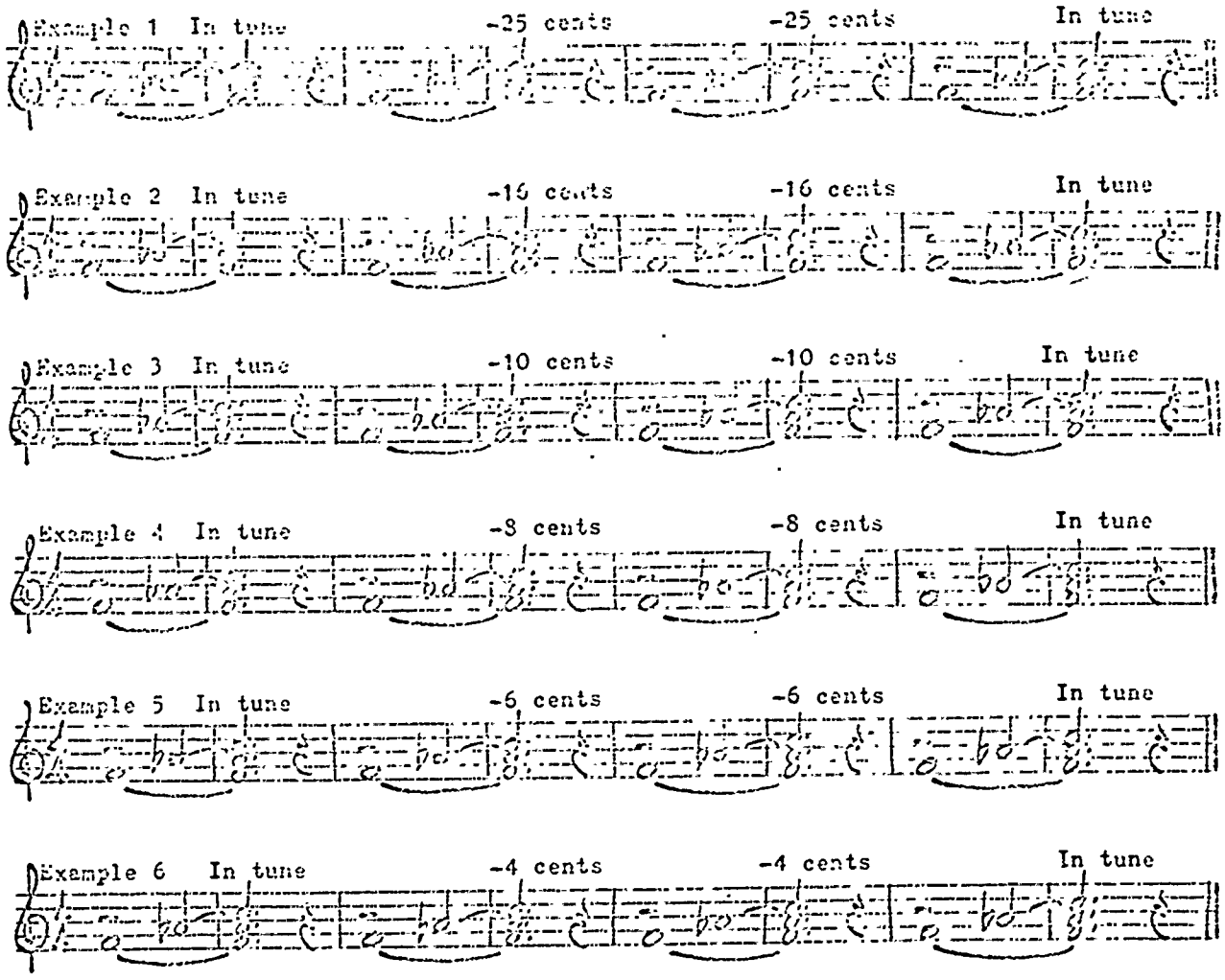


TAPE 4B: Part I, Major triads in equal temperament with the fifths sharp.

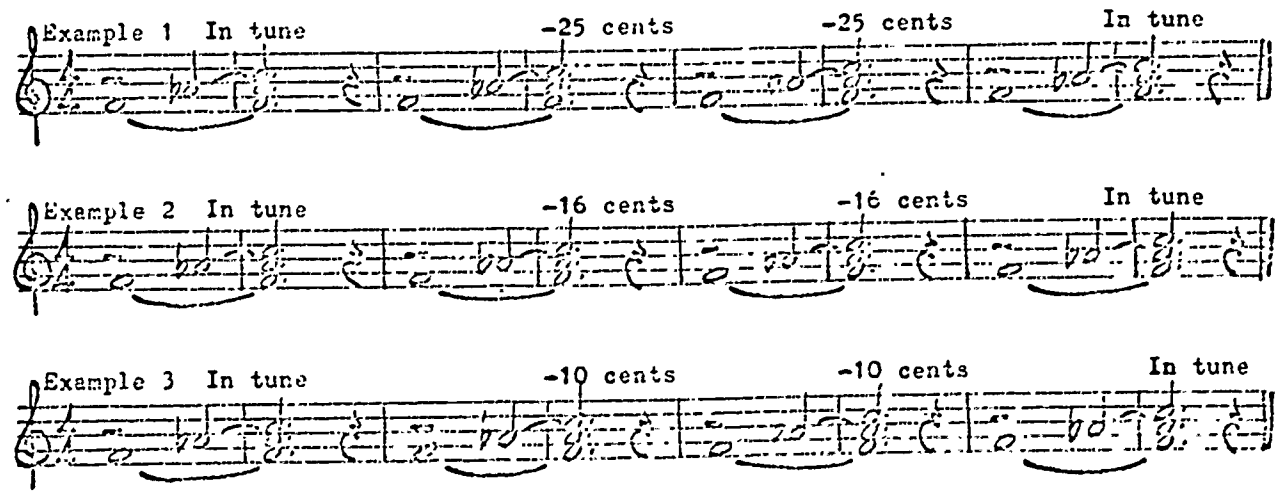


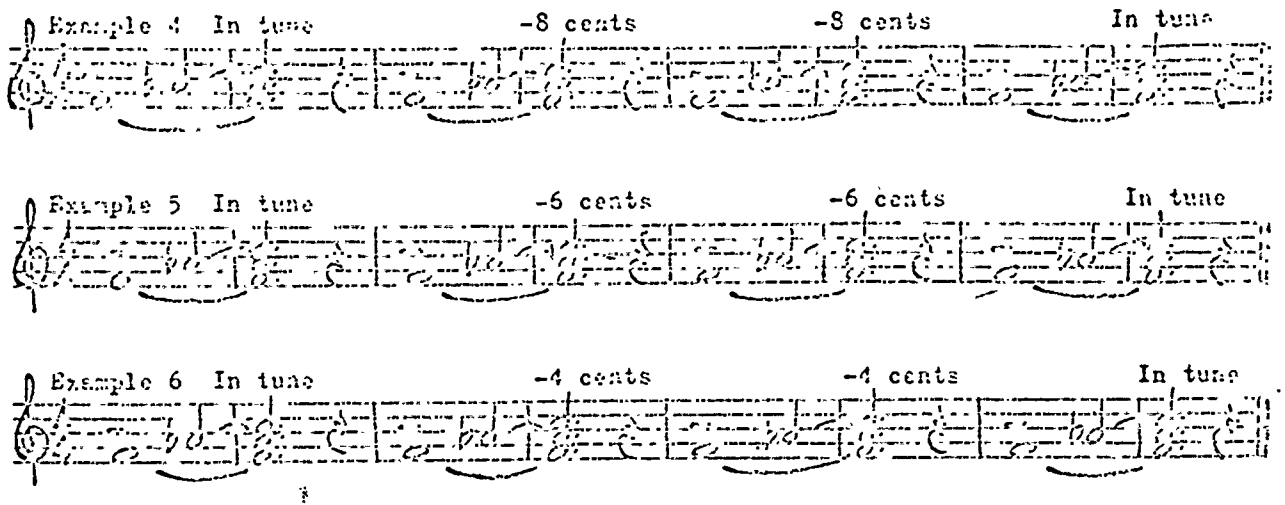

Example 4 In tune
+8 cents
+8 cents
In tune
Example 5 In tune
+6 cents
+6 cents
In tune
Example 6 In tune
+4 cents
+4 cents
In tune

TAPE 5A: Part II, Minor triads in equal temperament with the minor thirds flat.

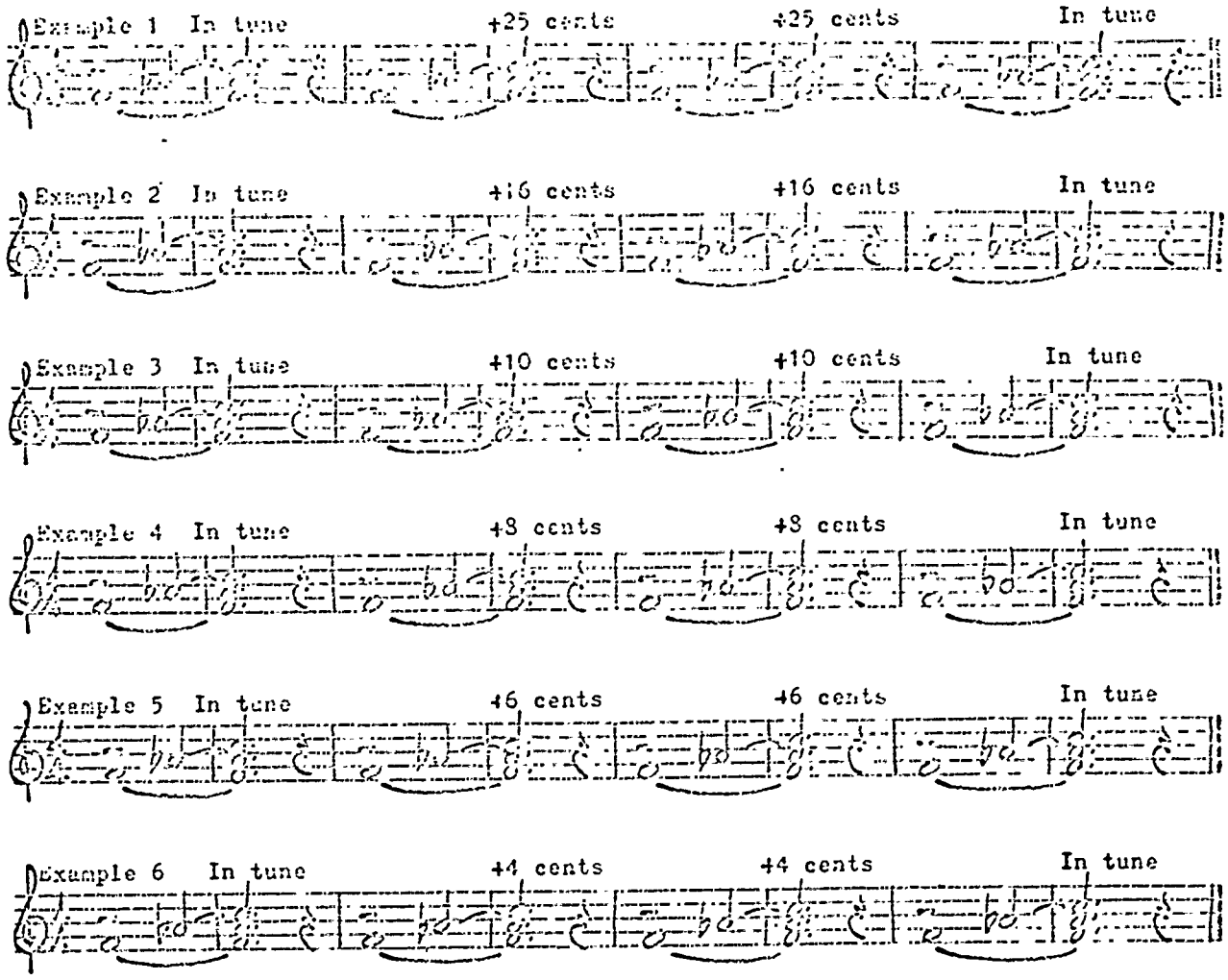


TAPE 5B: Part II, Minor triads in equal temperament with the fifths flat.

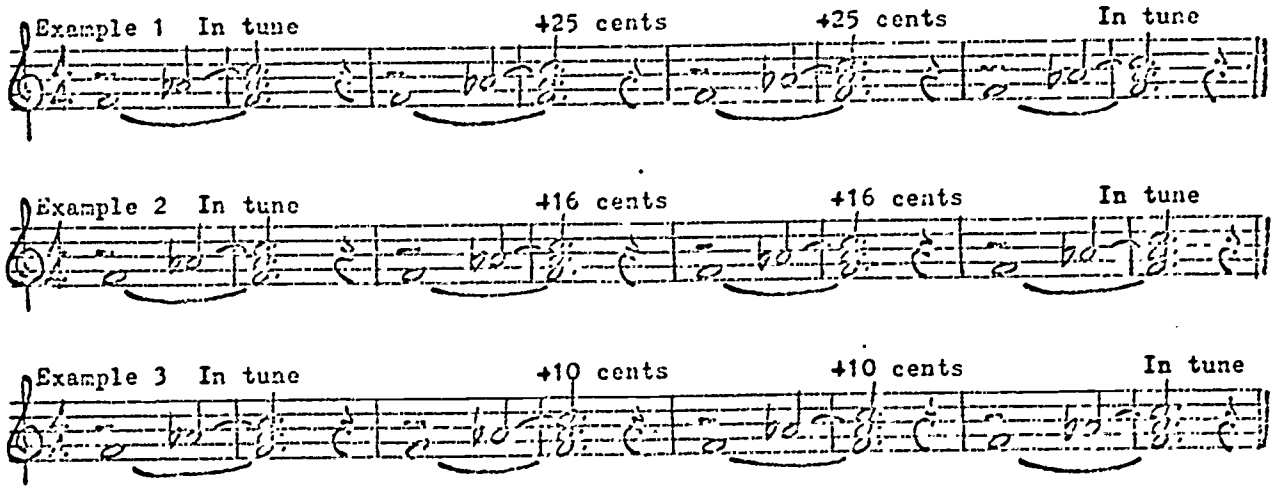


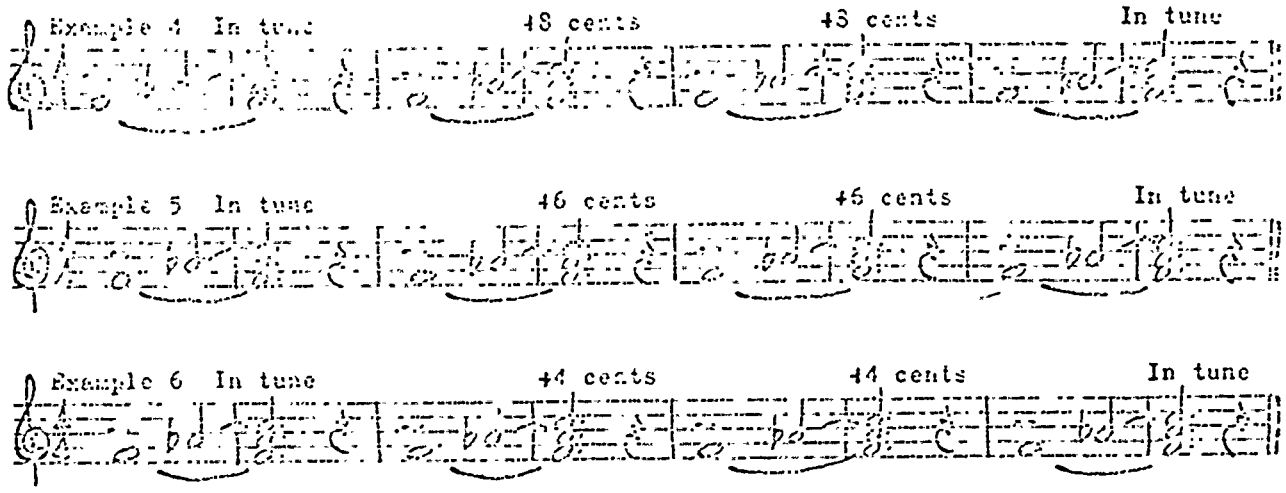

Example 4 In tune
-8 cents
-8 cents
In tune
Example 5 In tune
-6 cents
-6 cents
In tune
Example 6 In tune
-4 cents
-4 cents
In tune

TAPE 5A: Part I, Minor triads in equal temperament with the minor thirds sharp.



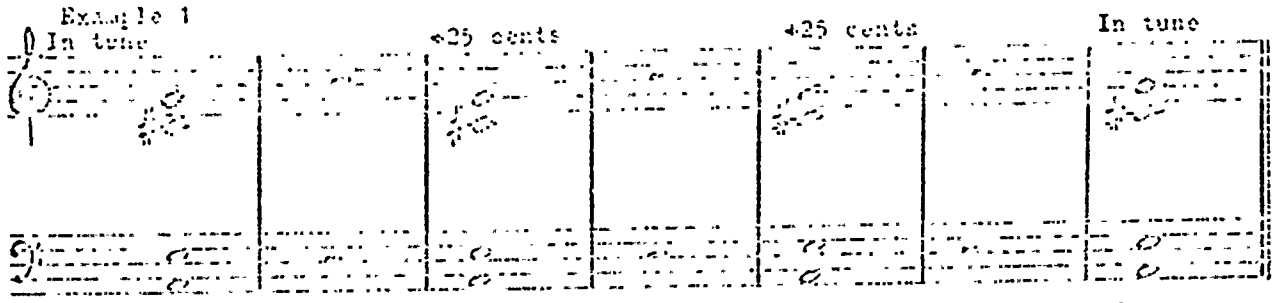
TAPE 5B: Part I, Minor triads in equal temperament with the fifths sharp.



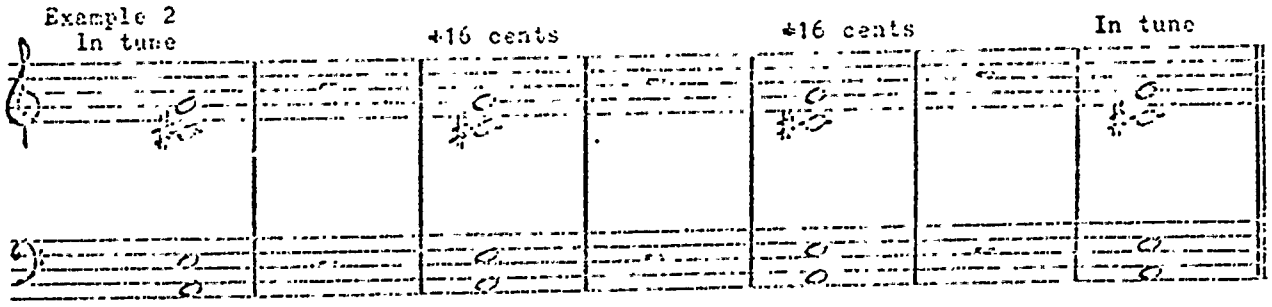

Example 4 In tune
48 cents
48 cents
In tune
Example 5 In tune
46 cents
46 cents
In tune
Example 6 In tune
44 cents
44 cents
In tune

TAPE 6: Dominant seventh chord in equal temperament with the sevenths sharp

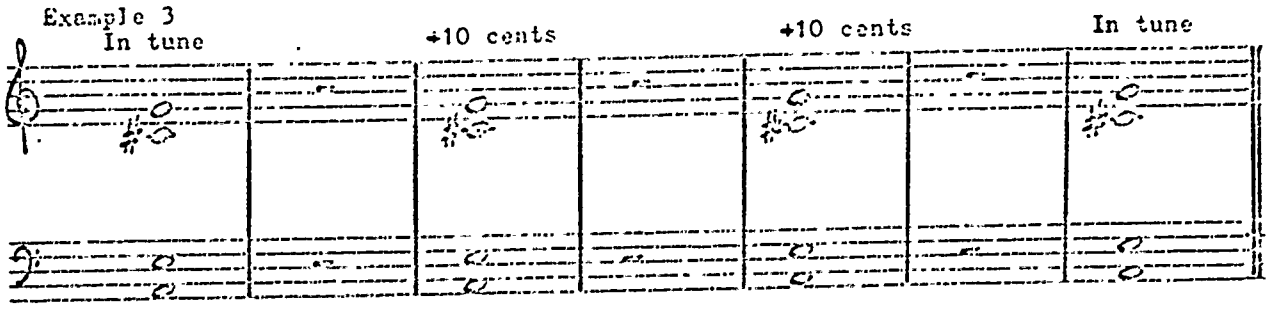
Example 1



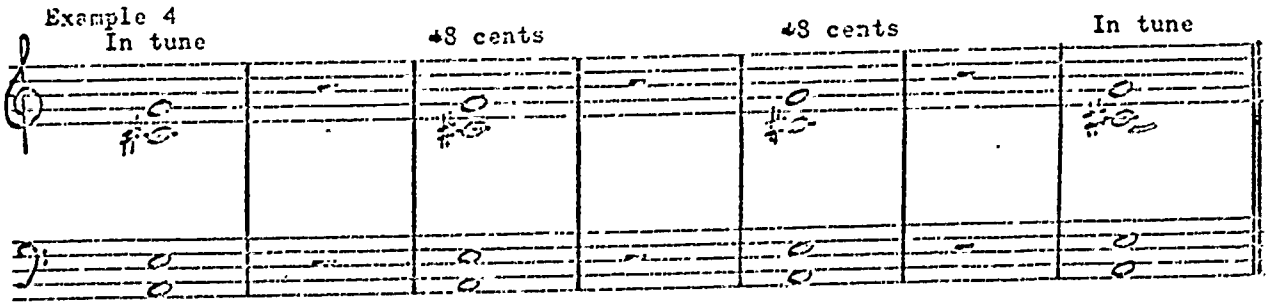
Example 2



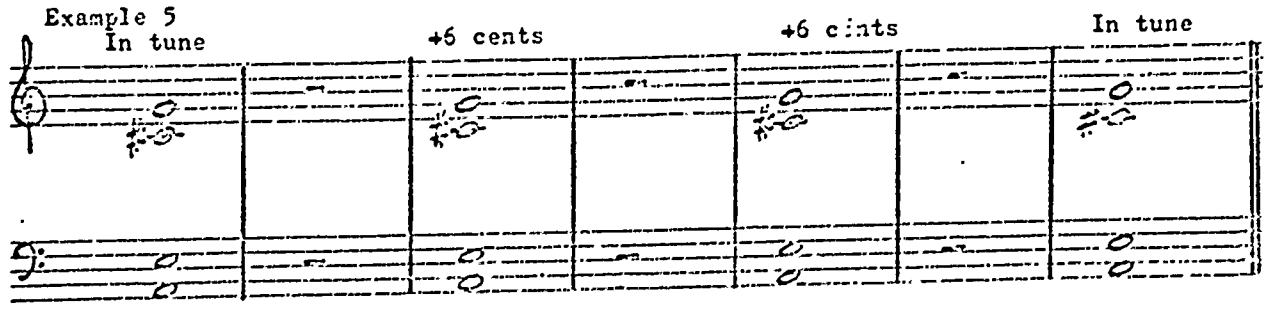
Example 3



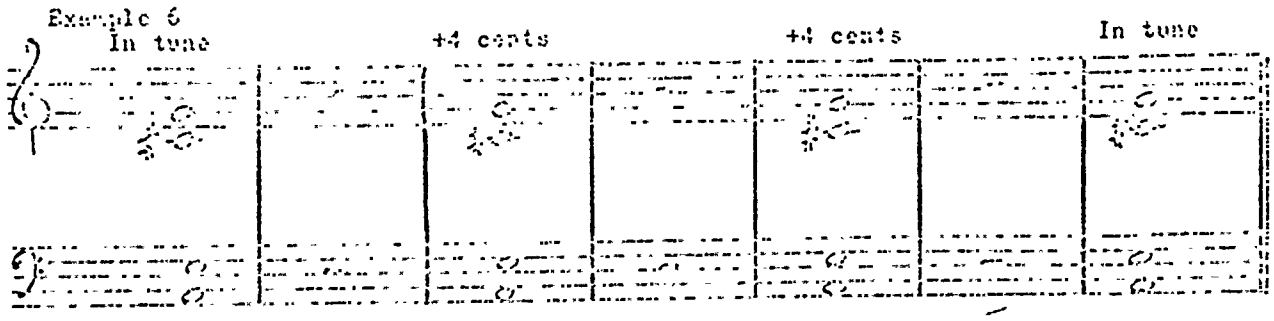
Example 4



Example 5

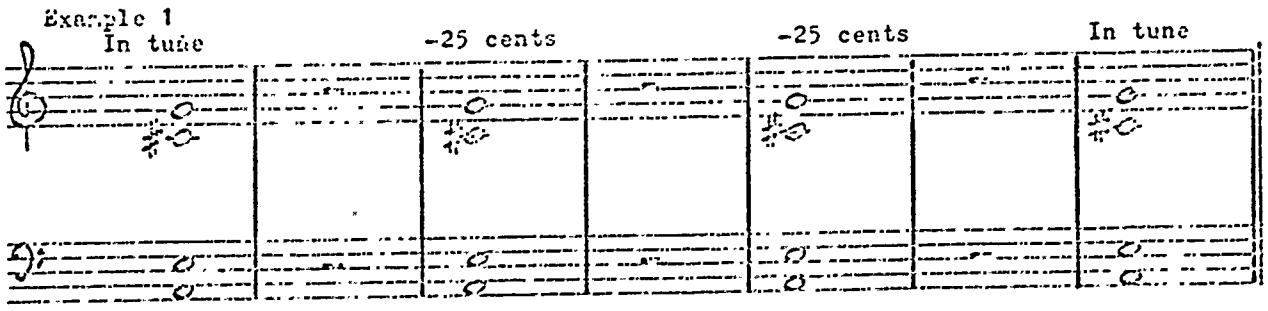


Example 6

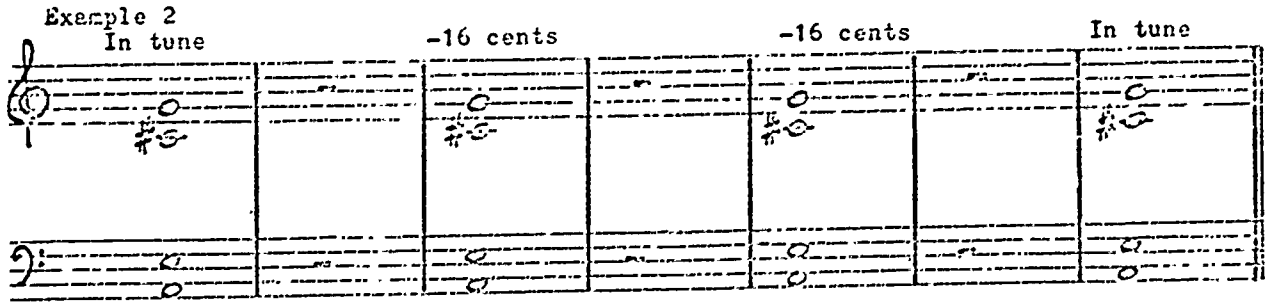


TAPE 6B: Dominant seventh chord in equal temperament with the sevenths flat

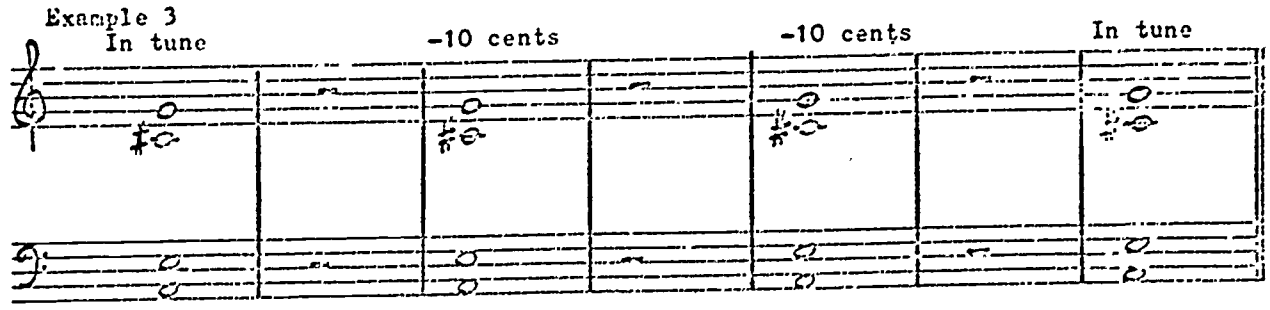
Example 1



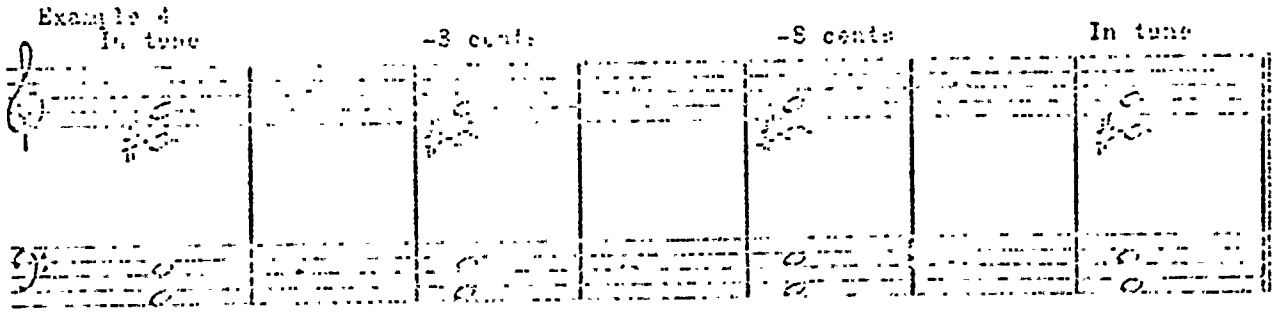
Example 2



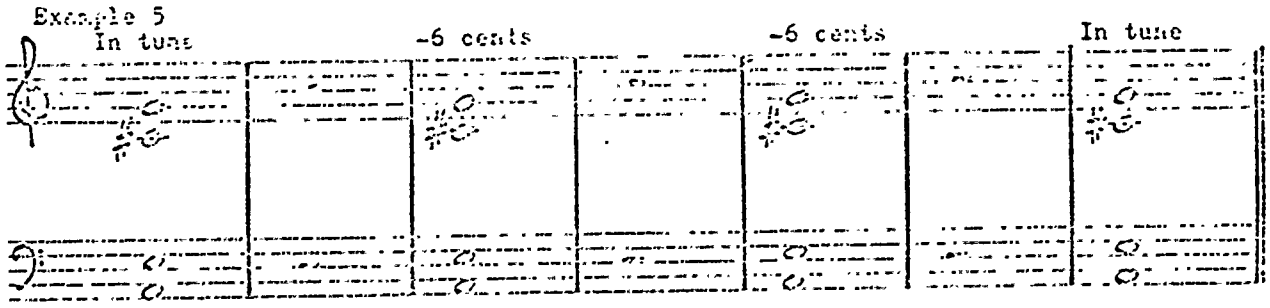
Example 3



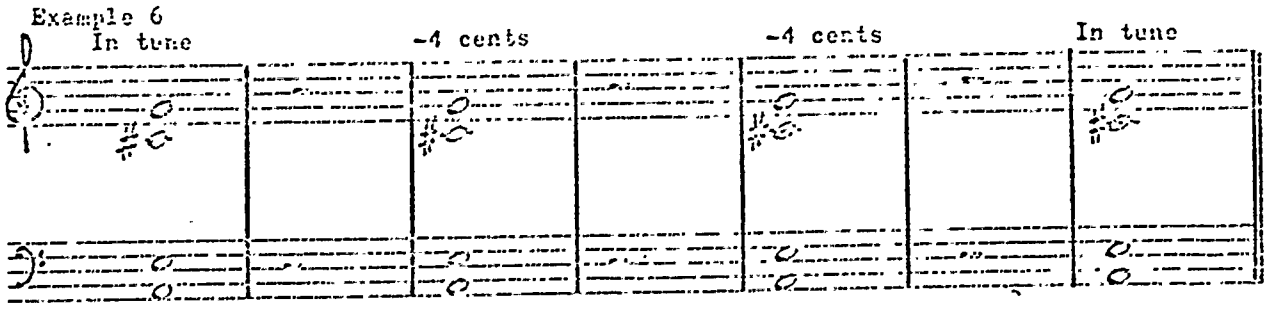
Example 4



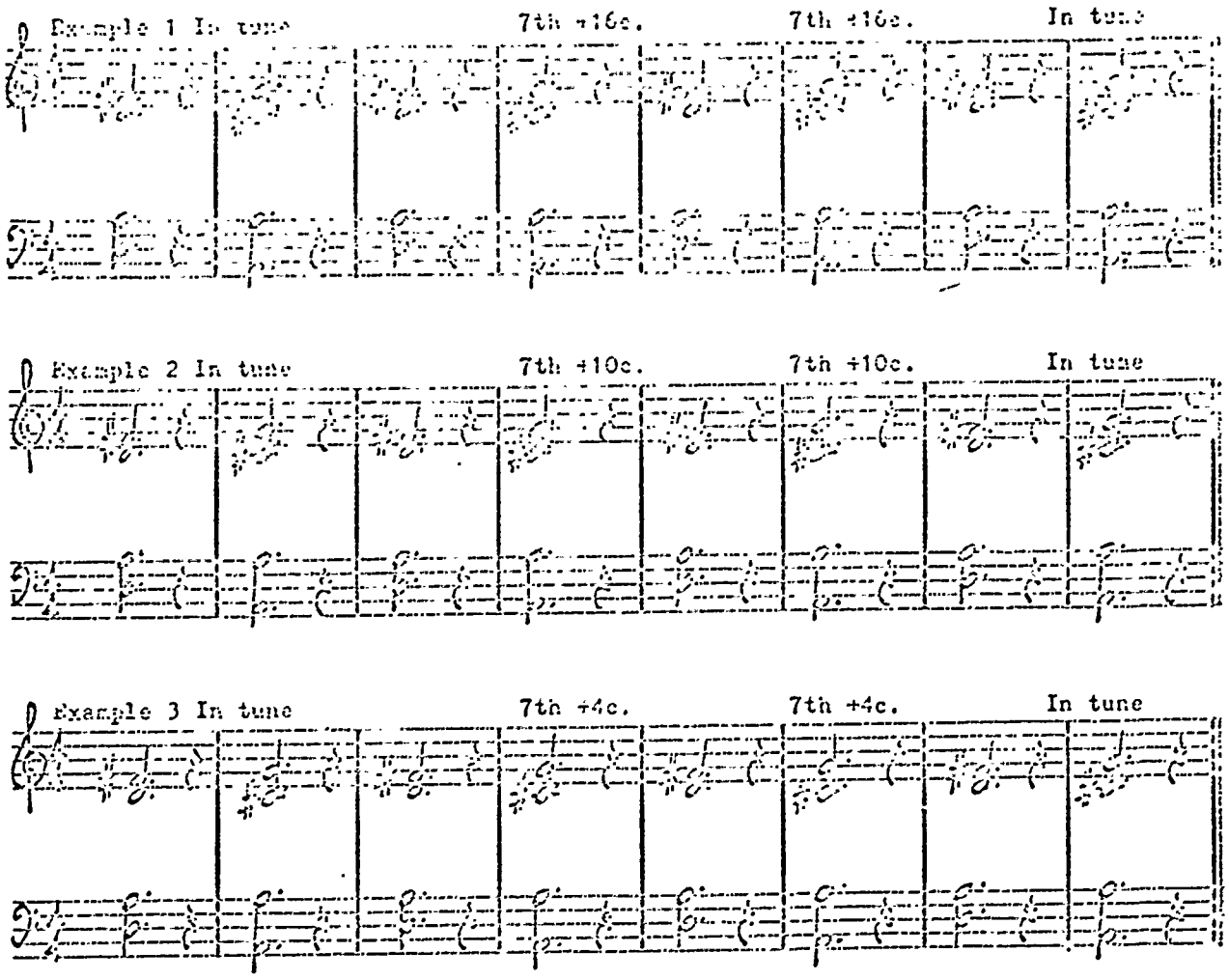
Example 5



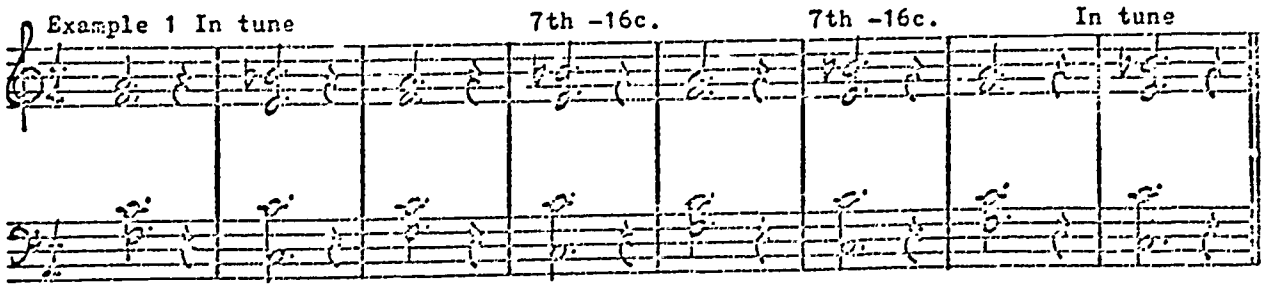
Example 6

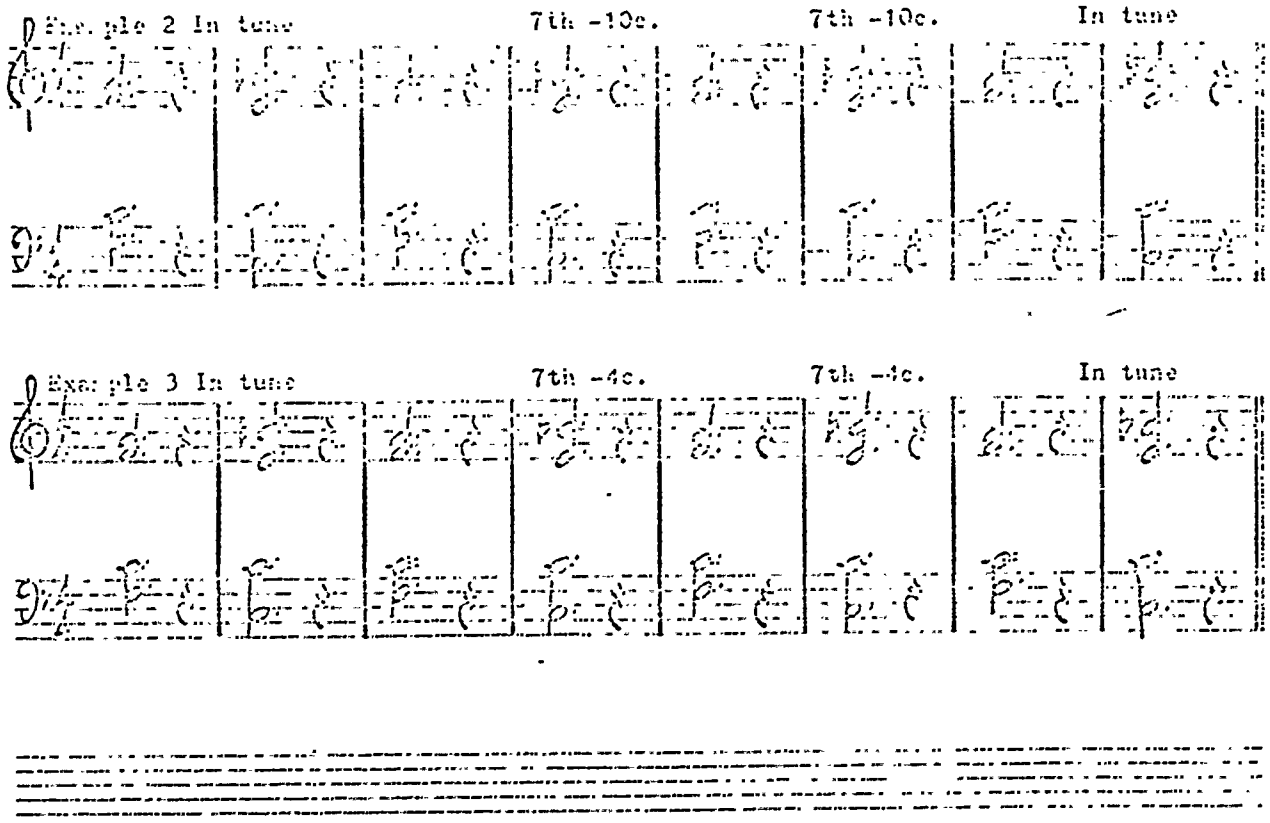


TAPE 7A, Part I: I to V_7 cadence in major in equal temperament with the sevenths of the dominant chord sharp.

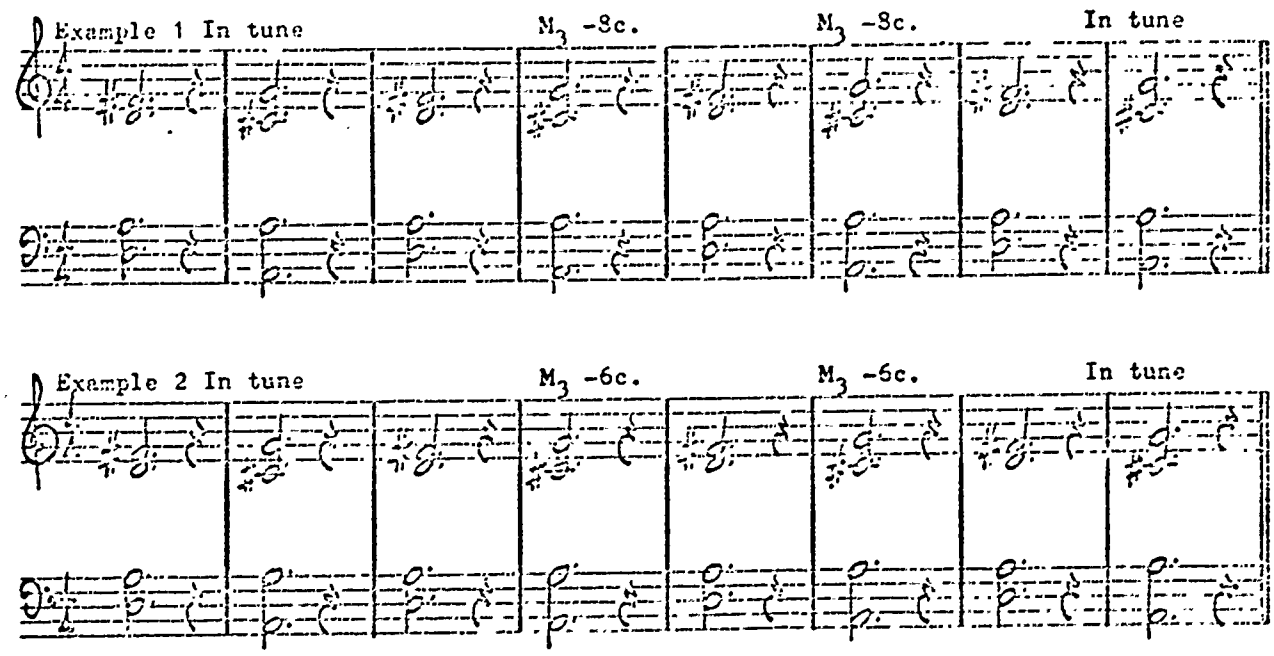


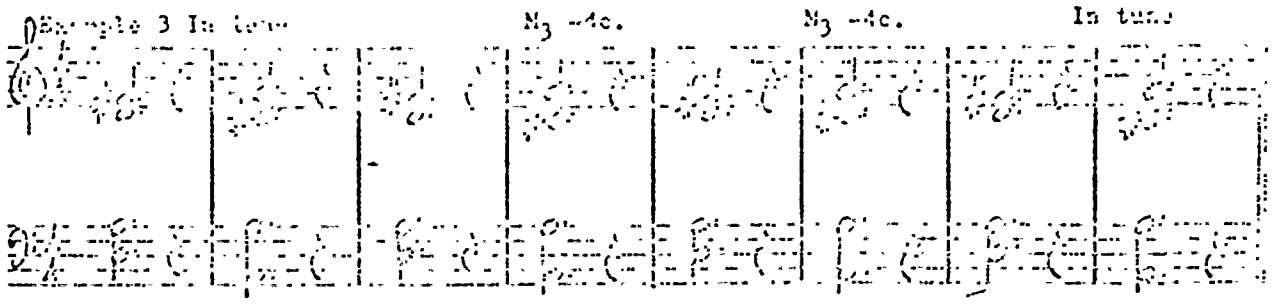
Part II: I to V_7 cadence in major in equal temperament with the sevenths of the dominant chord flat.



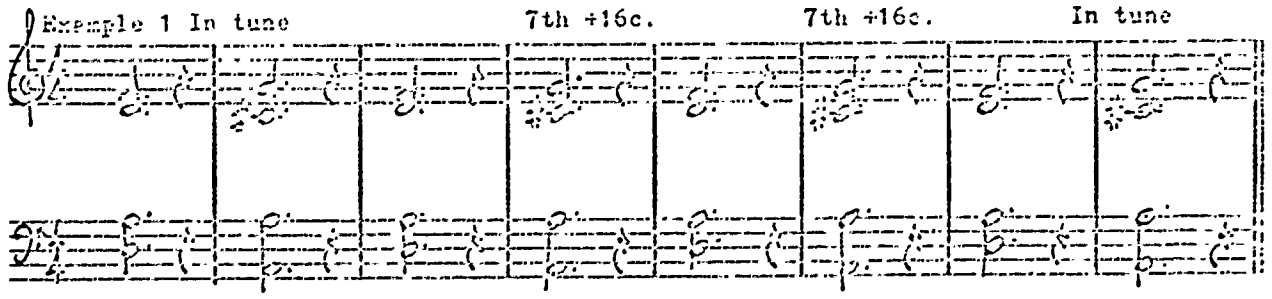


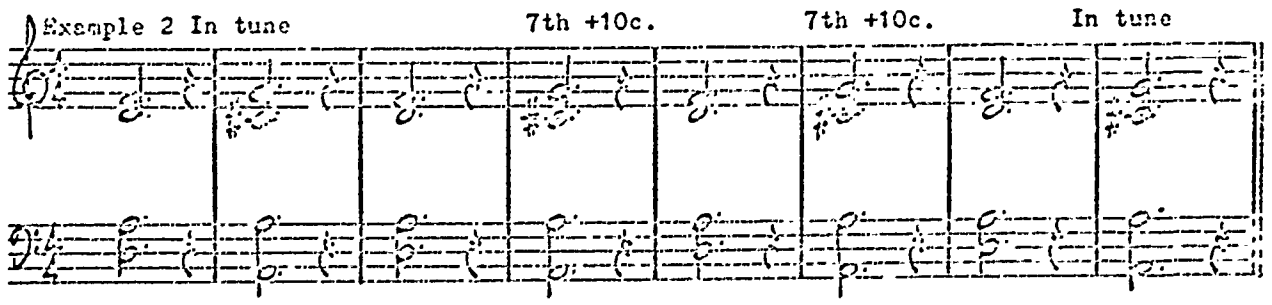
Part III: I to V_7 cadence in major in equal temperament with the thirds of the dominant chord flat.

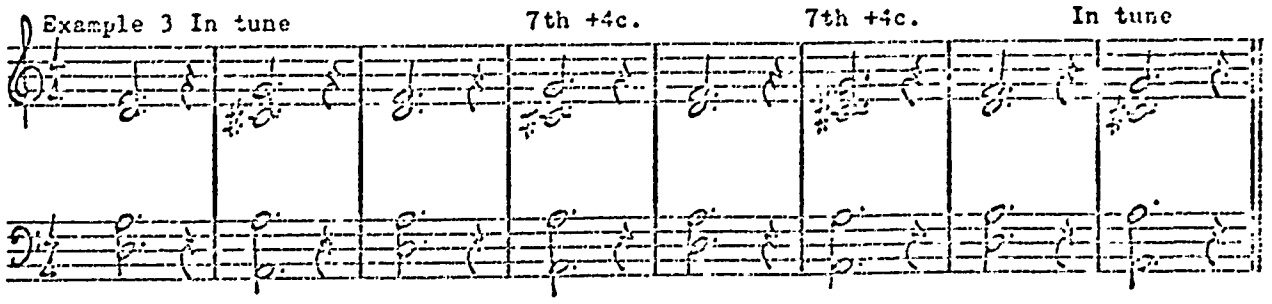




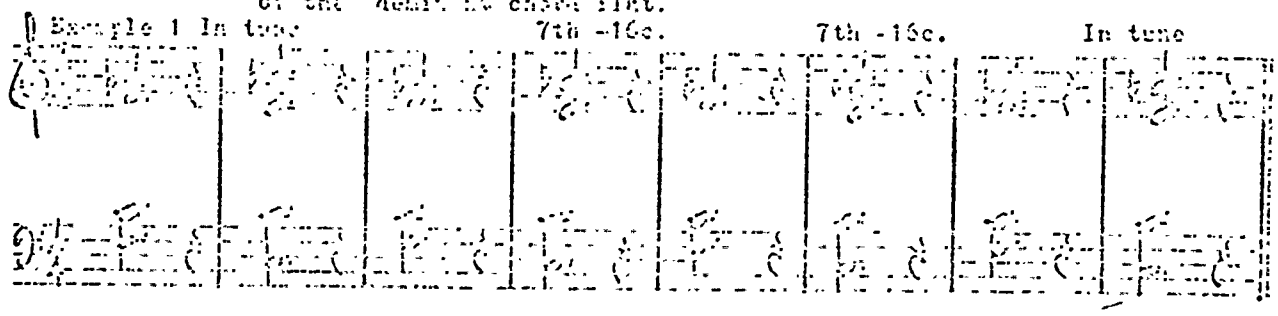
Part IV: I to V_7 cadence in minor in equal temperament with the sevenths of the dominant chord sharp.

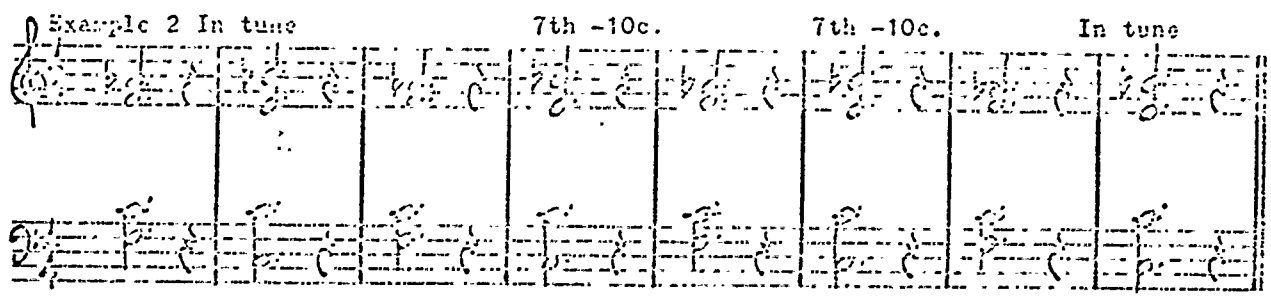


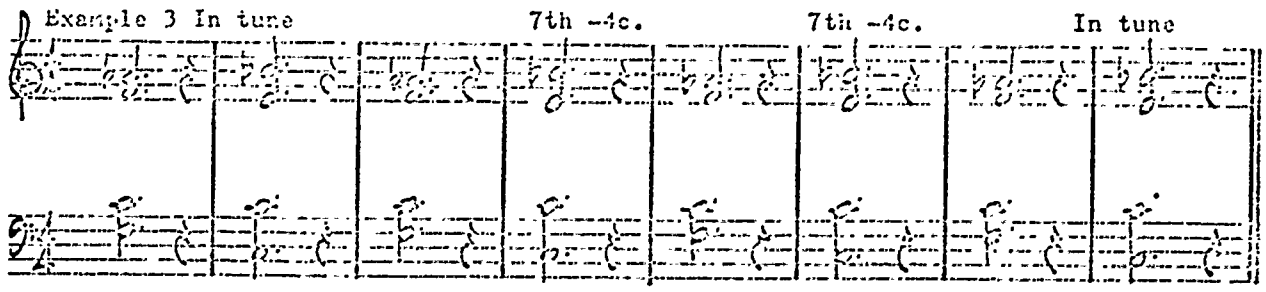




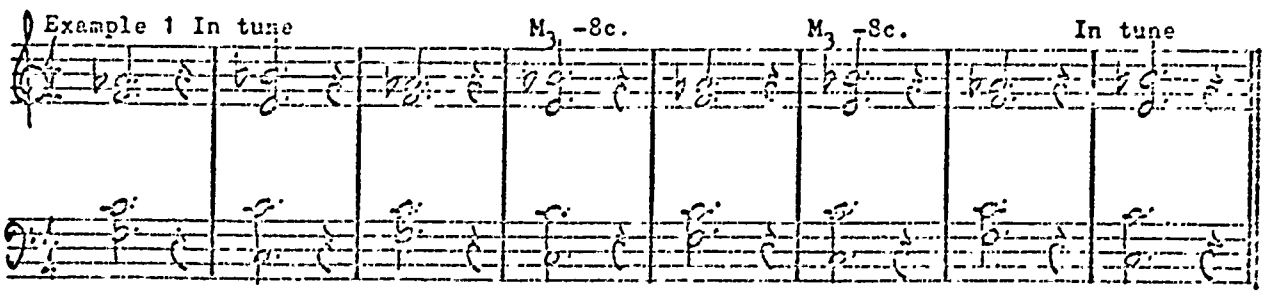
Part V: I to V_7 cadence in minor in equal temperament with the seventhe of the dominant chord flat.

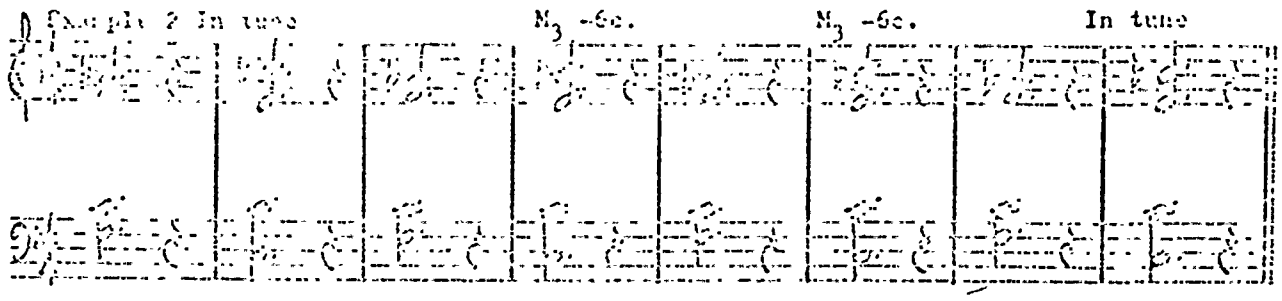


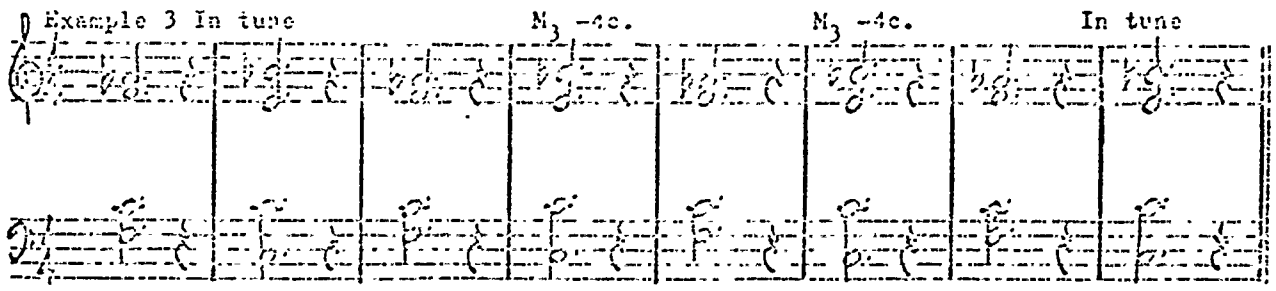




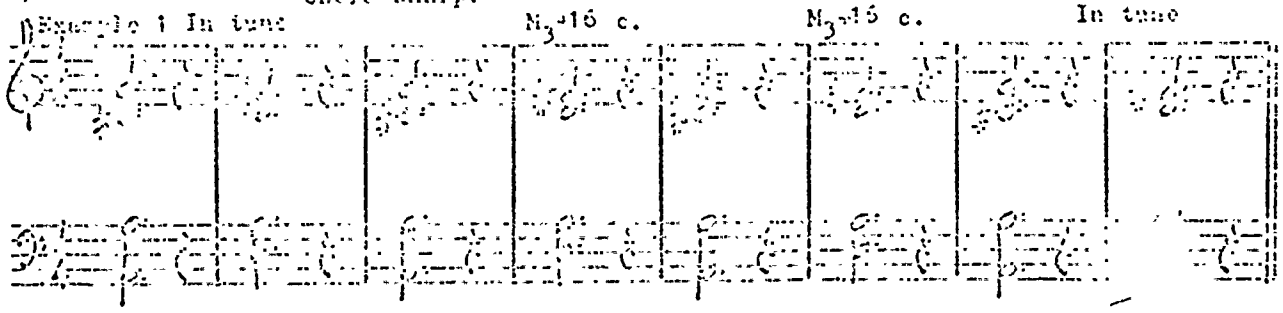
Part VI: I to V_7 cadence in minor in equal temperament with thirds of the dominant chord flat.

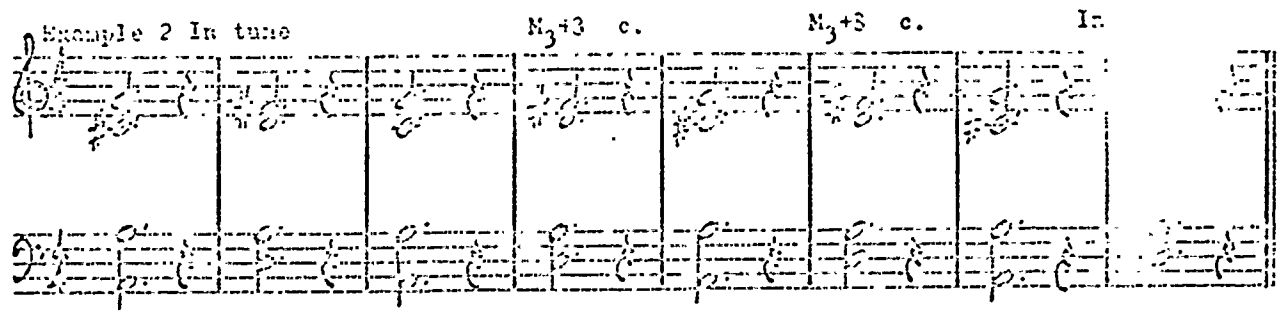


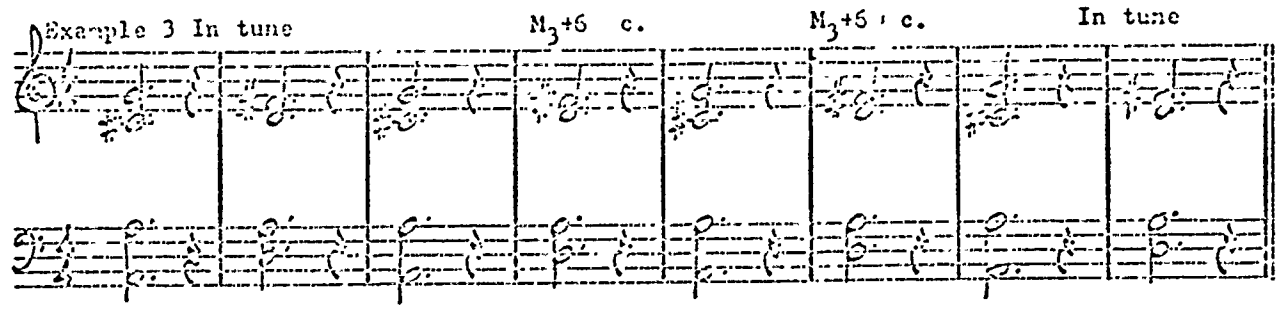

Example 2 In tune
M3 -6c.
M3 -6c.
In tune


Example 3 In tune
M3 -4c.
M3 -4c.
In tune

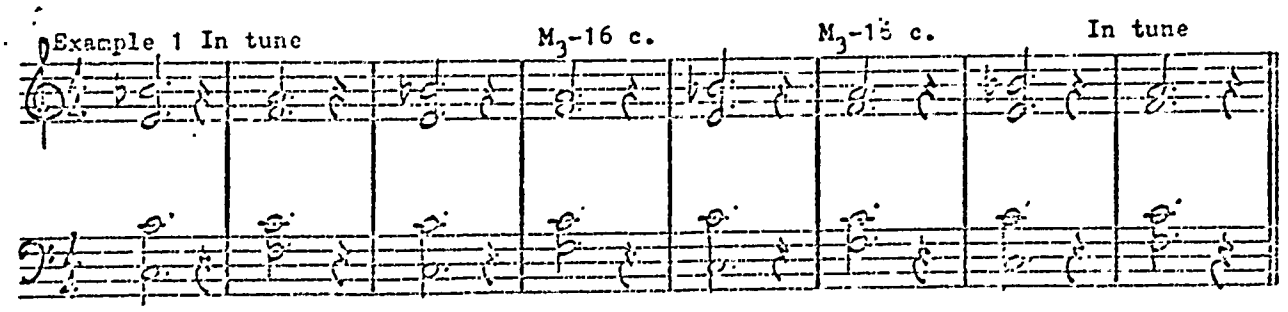
TAPE #5, Part I: V_7 to I cadence in equal temperament with the thirds of the tonic chord sharp.

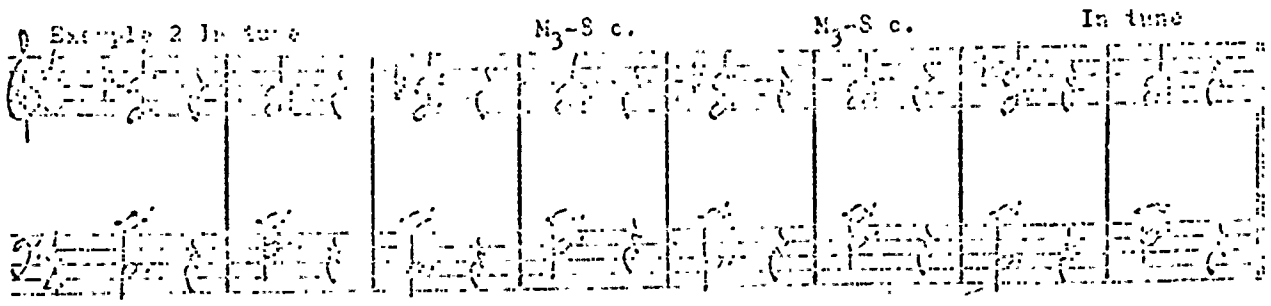


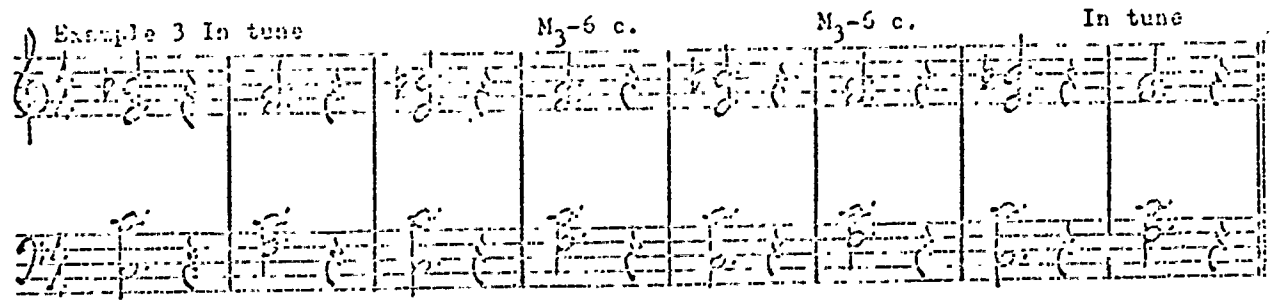




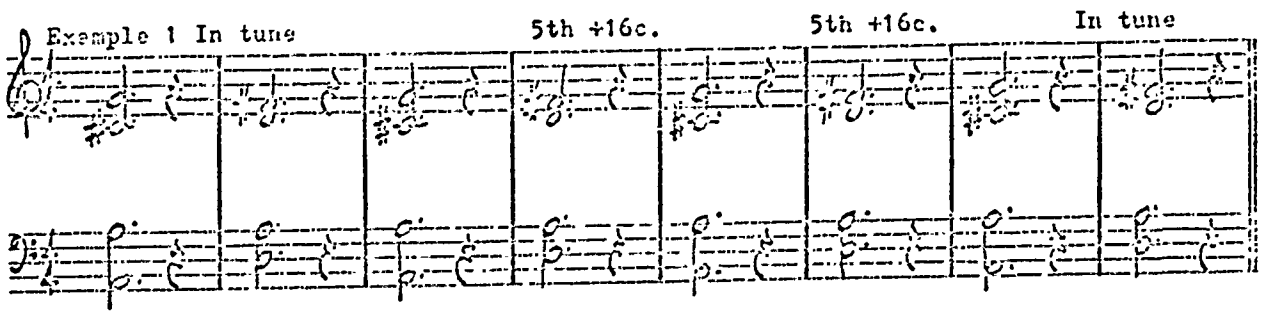
Part II: V_7 to I cadence in equal temperament with the thirds of the tonic chord flat.

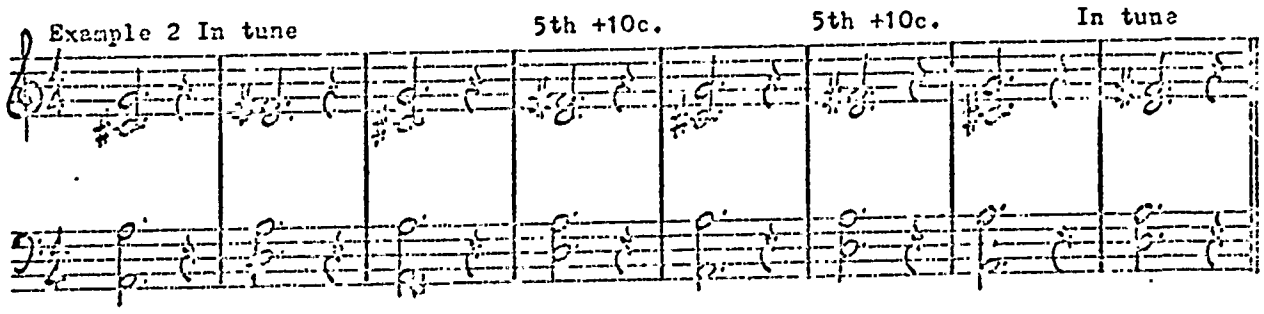


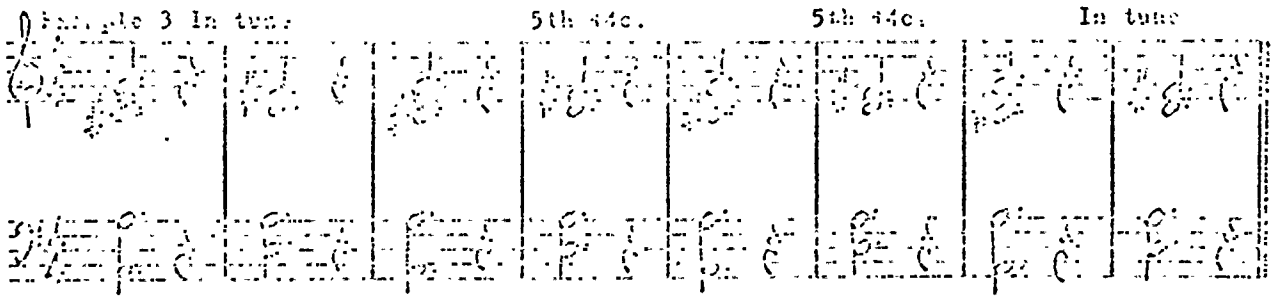




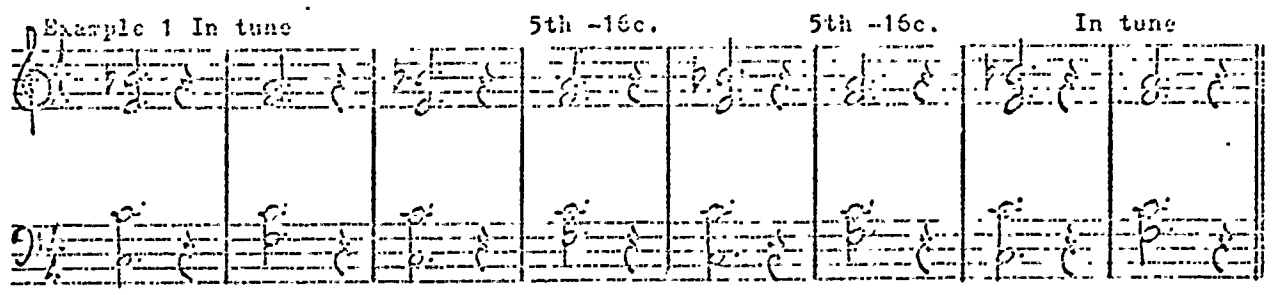
Part III: V_7 to I cadence in equal temperament with the fifths of the tonic chord sharp.

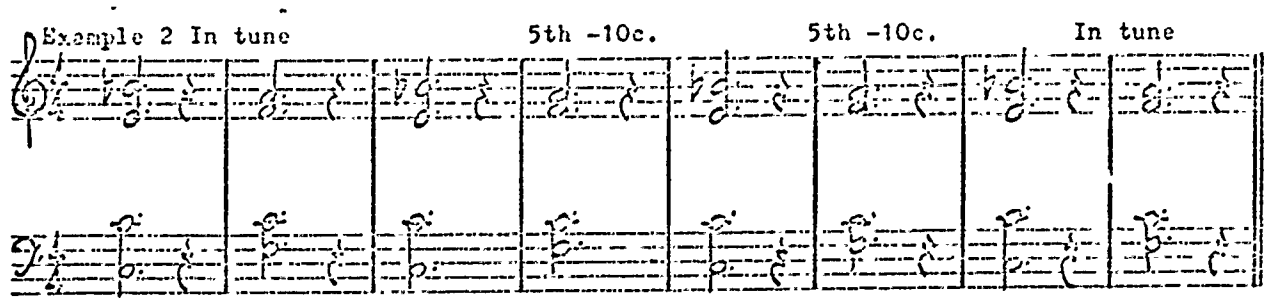


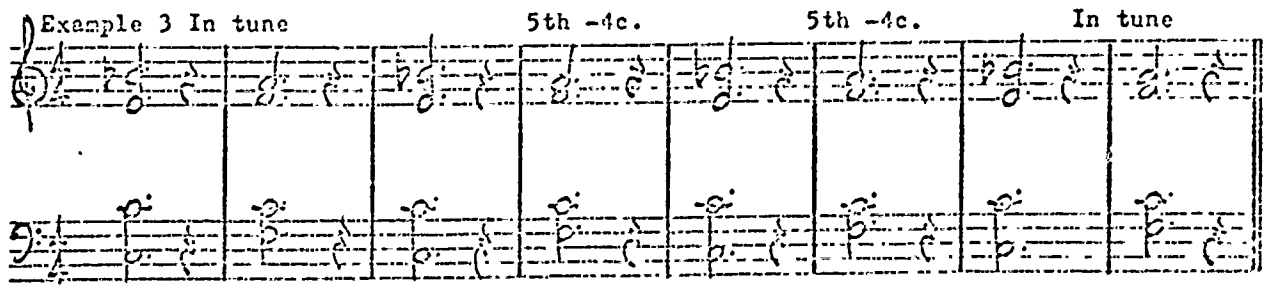




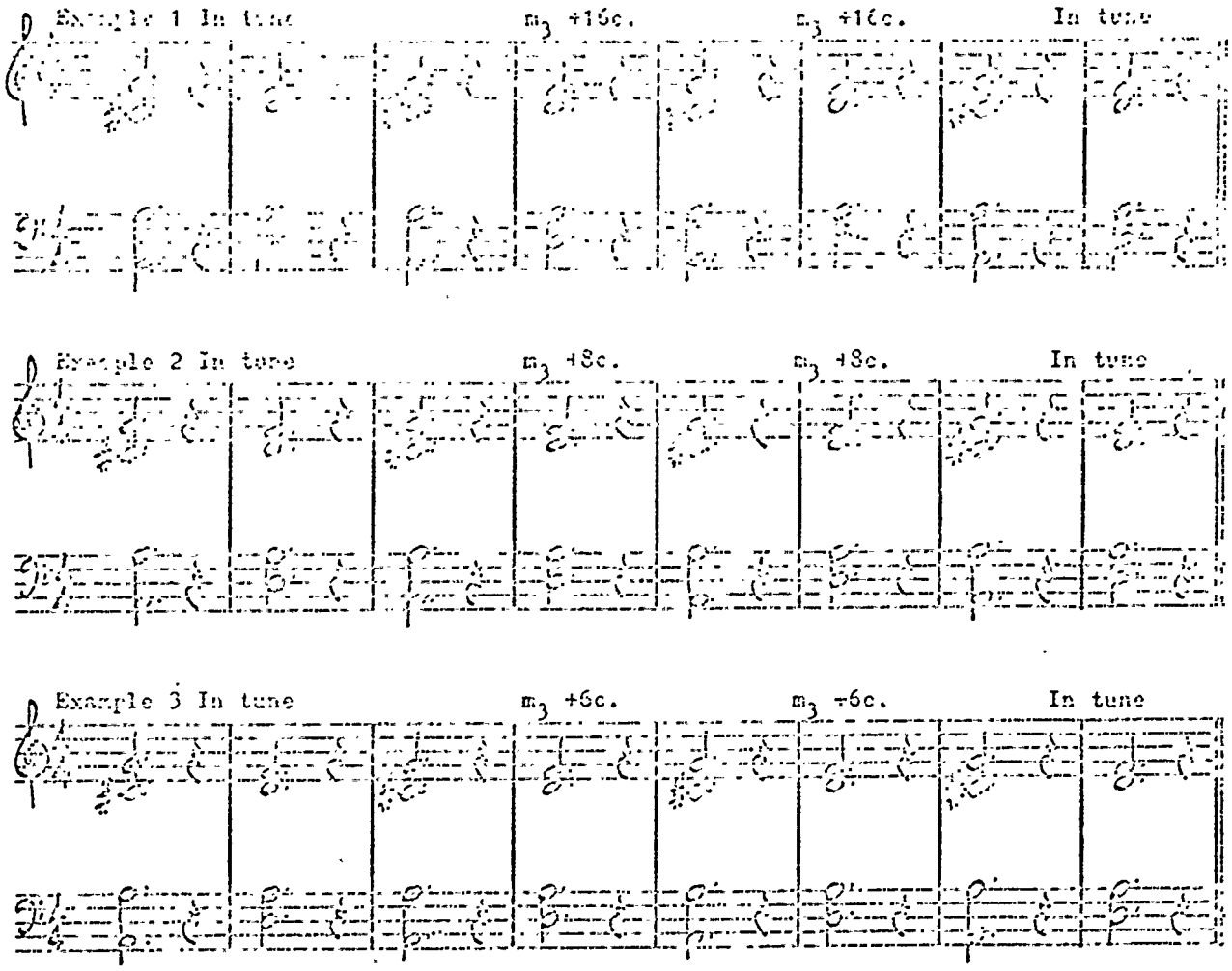
Part IV: V_7 to I cadence in equal temperament with the fifths of the tonic chord flat.



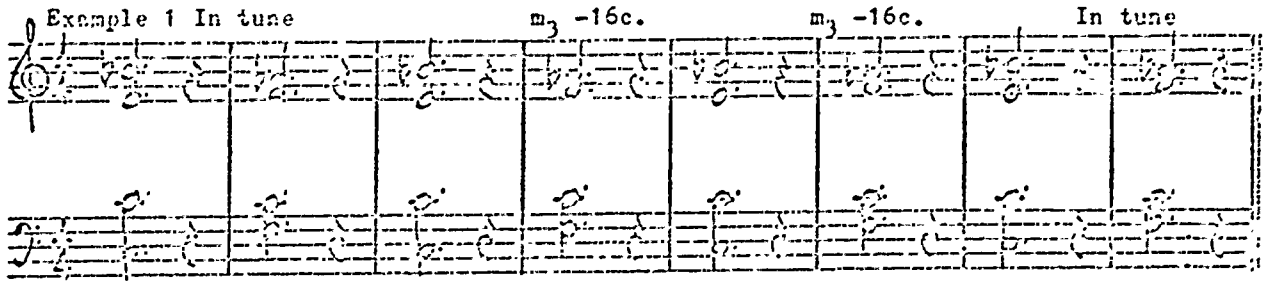


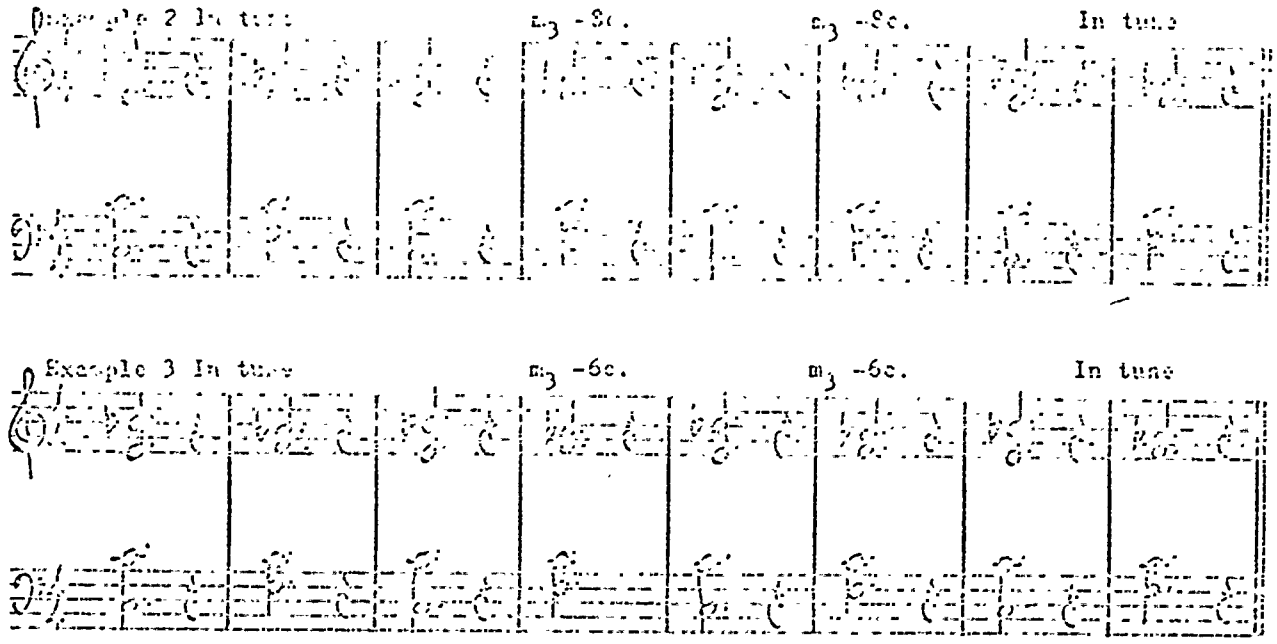


Part V: V_7 to I cadence in minor in equal temperament with the minor thirds of the tonic chord sharp.

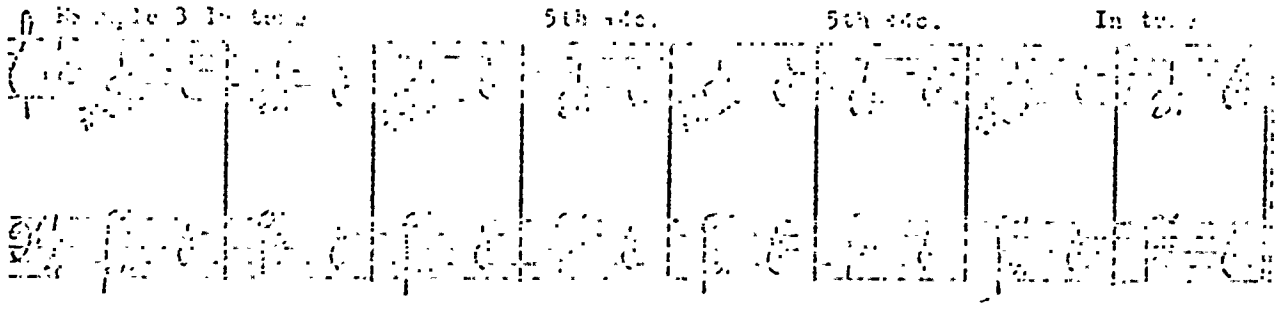


Part VI: V_7 to I cadence in minor in equal temperament with the minor thirds of the tonic chord flat.

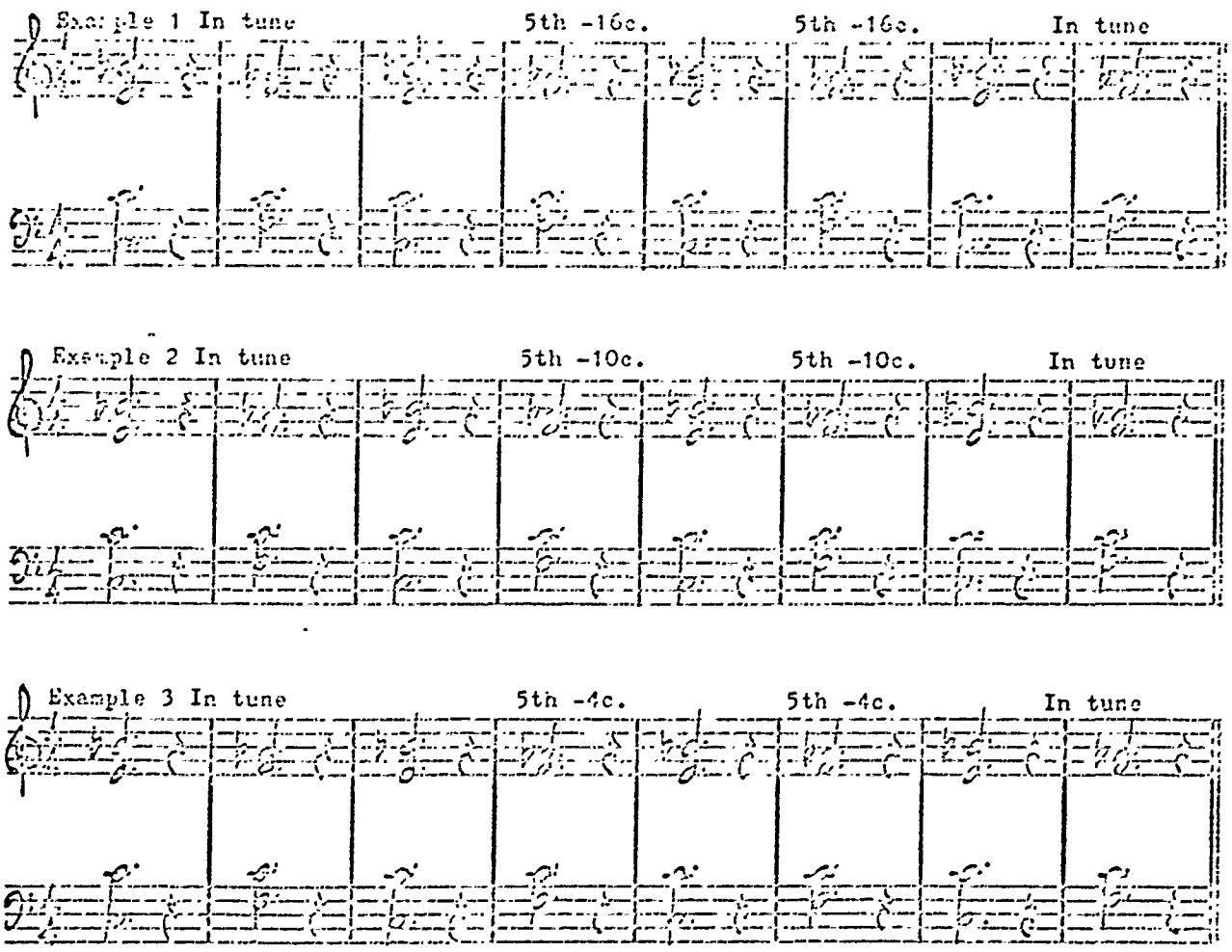




Part VII: V_7 to I cedence in minor in equal temperament with the fifths of the tonic chord sharp.



Part VIII: V_7 to I cadence in minor in equal temperament with the fifths of tonic chord flat.



APPENDIX C

PRETEST/POSTTEST DESCRIPTION AND FORM

The pretest/posttest was constructed by extracting items from Tapes 7A and 7B and splicing them to form the required sequence. This process was used to insure the accuracy of the in-tune cadences and the out-of-tune cadences, and to have an exact duplicate of the study material.

The test incorporated twenty items representing errors on each voice, that is, on the major third, the minor third, the fifth, and the minor seventh. To minimize guessing, three cadences were used that had no error.

The errors on the test were as follows:

Example 1 - Fifth ten cents flat in the tonic chord.
Example 2 - In tune
Example 3 - Fifth ten cents sharp in the tonic chord.
Example 4 - Major third eight cents sharp in the tonic chord.
Example 5 - Major third six cents flat in the tonic chord.
Example 6 - Major third eight cents flat in the dominant chord.
Example 7 - In tune.
Example 8 - Seventh ten cents sharp.
Example 9 - Seventh four cents flat.
Example 10 - Major third six cents flat in the dominant chord.
Example 11 - Minor third eight cents flat in the tonic chord.
Example 12 - Fifth ten cents sharp in the tonic minor chord.
Example 13 - In tune.
Example 14 - Minor third six cents sharp in the tonic chord.
Example 15 - Fifth ten cents flat in the tonic minor chord.
Example 16 - Fifth four cents flat in the tonic minor chord.
Example 17 - Major third ten cents flat in the dominant chord.
Example 18 - Major third six cents flat in the dominant chord.
Example 19 - Seventh ten cents sharp.
Example 20 - Seventh four cents flat.

Three trial samples were heard and discussed before the classes responded to the twenty-item test. The trial samples familiarized the

student with the procedure and the responses, established the necessary atmosphere and set the frame of mind necessary to listen and to respond.

The test required the student (1) to identify the chord in which an error occurred, and (2) to identify the voice in which the error occurred. The student responded by placing, in the appropriate box, a plus (+) for an error that was sharp, a minus (-) for an error that was flat, and an N if there was no error. Further, the student was asked to leave a blank if he could not respond to the error or lack of error. Each test example was heard twice.

Other information gathered on the pretest/posttest answer sheet was the degree program in which the student was enrolled, his major area of music study, his major instrument, and the number of theory classes that he completed.

The pretest/posttest was administered to both groups at the beginning and at the end of the experimental period.

Before beginning the experiment the pretest/posttest was administered to a group of students at a junior college to determine if: (1) the instructions were clear, (2) any additional information was required, (3) the answer form was workable, (4) enough time was allowed between the examples, and (5) fatigue would set in before the twenty examples were completed.

The trial run indicated that the instructions were clear, the answer form was no problem, and fatigue was not a problem. However, there was agreement that the two second interval between examples was too short.

As a result of the trial run the time interval between the examples was increased to four seconds. The pretest was run with this interval between examples and it was found to be satisfactory.

THE IMPROVEMENT OF SENSITIVITY TO AND THE ADJUSTMENT OF INTONATION IN THE ENSEMBLE

Name_____ _____ Degree program_____
Last: First: (B.M., B.A. in Ed., B.A.)

Major_____ Major Instrument_____
(Music Ed., Performance, Theory) (Voice, Keyboard, Trumpet, Clarinet)

Check the theory courses which you have completed

Mu 100_____ Mu 125_____ Mu 126_____ Mu 225_____

Mu 226_____ Other_____

On this tape you will hear four types of cadences: 1) V_7-I, 2) I-V_7, 3) V_7-i, and 4) i-V_7. You are asked to identify the voice in which an error in intonation is made, and the direction (sharp or flat) of that error.

On the answer sheet, mark the errors that are sharp with a plus (+), and the errors that are flat with a minus (−) in the column referring to the voice in which the error is heard. If there is no error in intonation leave the spaces blank. Each example will be performed twice.

Three trial samples will be heard:

	V_7			I or i		
	M_3	5th	7th	M_3 ′ m_3	5th	
Sample 1						
Sample 2						
Sample 3						

	V_7			I or i		
Example	M_3	5th	7th	M_3	P_3	5th
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

APPENDIX D

UNIT TEST DESCRIPTION AND FORM

Unit tests were administered once a week during the experimental period to these students in the experimental group. The students were asked to respond on in the pretest--errors that were sharp mark plus (+), errors that were flat mark minus (-), when no error was heard use an N, and if a decision could not be made, leave that example space blank.

All of the unit tests were extracted and respliced from the material that the experimental group listened to during the previous week. An in-tune example of the material being tested was played as a sample before each test was begun.

The first unit test contained six examples and it tested the student's ability to identify errors in the major third. Errors included three sharp-intervals examples and two flat-intervals examples, and one example with no error.

Test two contained six examples and it tested the student's ability to indentify errors in the minor third. Errors included three sharp-intervals examples and two flat-intervals examples, and one example had no error.

The third unit test examined the student's ability to identify errors in the fifth using six examples. Three examples were sharp, two were flat, and one was in tune.

Since Test Four involved the major triad, there were ten examples with an error in major thirds and in the fifths. Two examples, four and eight, were in tune. Two of the thirds were sharp--one by twenty-five cents and the other by six cents. The two flat thirds were flat by sixteen cents and by eight cents. The fifths were flat by sixteen cents and ten cents, and they were sharp by ten cents and twenty-five cents.

Test Five examined the minor triad, and it involved the same errors as outlined in Test Four.

The seventh in the dominant seventh chord was tested in the sixth week. Test Six contained six examples in the following sequence: flat--sixteen cents, sharp--sixteen cents, sharp--ten cents, in tune, flat--ten cents, and sharp--six cents.

Test Seven involved the I-V_7 cadence in major and in minor. Errors are only on the second chord. Eight examples were presented as follows:

In major:

seventh, sharp--sixteen cents
seventh, flat--sixteen cents
in tune
major third, flat--eight cents

In minor:

seventh, flat--sixteen cents
in tune
major third, flat--eight cents
seventh, sharp--sixteen cents

The eighth unit test involved the V_7-I cadence in major and in minor. As in the seventh test, errors of intonation were only on the second chord. Ten examples were presented as follows:

In major:

major third, sharp--sixteen cents
fifth, sharp--sixteen cents
in tune
major third, flat--sixteen cents
fifth, flat--sixteen cents
in tune

In minor:

minor third, sharp--sixteen cents
fifth, flat--sixteen cents
fifth, sharp--sixteen cents
minor third, flat--eight cents

Name_____

Date_____1968

Test #_____

SAMPLE: IN TUNE

EXAMPLE M3/M3 5th 7th

1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

APPENDIX E

SPECIFICATIONS OF THE TAPE RECORDERS AND THE MICROPHONES

The specifications for the Ampex #350 rate the frequency response at ± 2 decibels to range 30 cycles per second to 15,000 cycles per second. The signal-to-noise ratio when recording at 15 inches per second is minus 60 decibels, and the flutter and wow disturbance is .11% rms; for all practical purposes these factors are negligible.

Specifications for the Telefunken U-47 microphone rates the frequency response from 30cps to 20,000 cps, and the non-linear distortion as less than 0.9% over the entire range to 110 decibels. The microphones were filtered for frequencies below 150 cycles for the recording of the strings and for 80 cycles for the recording of the woodwinds. This procedure was used to maintain a high level of tape response and to insure more clarity between the recorded frequencies.

The students used the Wollensack #15008S with a Wollensack headset to listen to the tapes. Specifications for the Wollensack #15008S rate the frequency response at ± 3 decibels to range from 40 cps to 15,000 cps at 7-½ ips. The signal-to-noise ratio is minus 48 decibels, and the flutter and wow disturbance is less than 0.25% rms.